1998 LOWER GRANITE DAM
SMOLT MONITORING PROGRAM

Annual Report 1998

DOE/BP-02117-1

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views of this report are the author's and do not necessarily represent the views of BPA.

This document should be cited as follows:

Verhey, Peter; C. Morrill, S. Witalis, D. Ross, Washington State Dept. of Fish and Wildlife, 1998 Lower Granite Dam Smolt Monitoring Program, Annual Report to Bonneville Power Administration, Portland, OR, Contract No. 98FG02117, Project No. 87-127, 90 electronic pages (BPA Report DOE/BP-02117-1)

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1998 LOWER GRANITE DAM SMOLT MONITORING PROGRAM

ANNUAL REPORT

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Project Number 87-127
Contract Number 98FG02117

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Summary

The 1998 fish collection season at Lower Granite was characterized by relatively moderate spring flows and spill, moderate levels of debris, cool spring, warm summer and fall water temperatures, and increased chinook numbers, particularly wild subyearling chinook, collected and transported. A total of 6,977,214 juvenile salmonids were collected at Lower Granite. Of these, 6,729,707 were transported to release sites below Bonneville Dam, 6,542,402 by barge and 187,305 by truck. An additional 236,414 fish were bypassed back to the river. A total of 124,741 salmonids were examined in daily samples. The prototype Surface Bypass Collector (SBC), in front of turbine units 4 through 6, was tested for the third consecutive year. Testing during the spring fish migration began on April 13 and ended on May 29. The Behavioral Guidance Structure (BGS), a floating guide-wall that connects to the south end of the SBC extending upstream, was tested during the spring and summer. It was moved into position in front of the surface collector on June 29 and tests were conducted from July 1 to July 18. The National Marine Fisheries Service (NMFS) PIT-tagged 99,902 hatchery and 16,976 wild yearling chinook for the Transport Evaluation Marking Study. Fish were taken from daily samples and from samples collected in the east raceways between April 7 and June 30.

Introduction

The Fish Passage Center's Smolt Monitoring Program is designed to provide a consistent, real-time database on fish passage and document the migrational characteristics of the many stocks of salmon and steelhead in the Columbia Basin. Each of the SMP sites collects and provides fish passage as well as pertinent flow, spill and/or other site specific data required for the SMP on a daily basis throughout the season to the FPC. FPC staff oversees and guides the SMP sampling programs at each of the sites. The Fish Passage Center, as a representative of the fishery agencies and tribes, uses this data to work with the fishery managers to seek appropriate flow and spill measures to enhance smolt passage and survival as identified in the hydrosystems operations requirements set forth in NMFS Biological Opinion and in the Northwest Power Planning Council's Fish and Wildlife Program.

Lower Granite Dam (LGR) is located on the Snake River, approximately 107.5 miles upstream from the confluence with the Columbia River. This dam is the first of eight that migratory juvenile salmonids in the Snake River and its tributaries encounter on their way to the ocean. It is one of four juvenile fish collection and transportation facilities operated by the Corps of Engineers on the Snake and Columbia Rivers. Fish are collected and either bypassed back to the river or transported in barges and trucks to release locations below Bonneville Dam. From Bonneville, the smolts complete the remaining 140-mile journey to the ocean on their own.

At Lower Granite Dam, SMP staff collect and record data by inspecting a sample of each day's total smolt collection. The SMP has been active at Lower Granite since 1984 and has been operated by the Washington State Department of Fish and Wildlife (WDFW) since 1988. Staff technicians and biologists identify and record the following information for each fish sampled: species, rearing type (hatchery or wild), freeze brands and other external marks or tags including elastomer tags, fin clips, injuries and external signs of disease and/or stress. Lengths and weights are taken on a subsample of up to one hundred fish of each species every other day. The staff

also collects daily river flow and/or spill and temperature data, monitors and assists on-site research activities of other agencies as needed, maintains accurate records of sample and collection data, transmits daily reports to the FPC and prepares an annual report.

River Conditions

Flow

Average monthly river flows past Lower Granite during the 1998 smolt collection season were close to or higher than the five-year average (Table 1). River flows for the last few days of March were between 60 and 80 kcfs (Appendix 1, Table 1). Flows for the first three weeks of April averaged nearly 50 kcfs and increased to about 90 kcfs in the last week of the month. River flows first exceeded 100 kcfs on May 2 and peaked for the year at 214.6 kcfs on May 28, ten days later than in 1997 when flow peaked at 225.9 kcfs on May 18. May flows this year were the second highest in the last five years. Flows exceeded 150 kcfs for eleven days this year between May 23 and June 2. Flows declined steadily throughout June, dropping below 100 kcfs on June 19 and then down to 85 kcfs by the end of June. Average flows in June were second lowest of the last five years. July flows were the second highest in the last five years, averaging 80 kcfs during the first week and 62 kcfs for the month. River flows decreased to less than 50 kcfs on July 30, approximately 15 days earlier than in 1997 but six days later than the five-year average. Flows in August were the second lowest in five years averaging 33.7 kcfs and decreasing to about 20 kcfs by the end of the month. The season's low flow occurred in September with an average of 16.6 kcfs on September 8, about 10 kcfs less and four days earlier than in 1997. Mid-September and October flow averages were near 30 kcfs before dropping below 20 kcfs on October 20. Flows on the final day of the season on November 1 were 16 kcfs. Daily average flows exceeded 100 kcfs for 48 days, 150 kcfs for eleven days and 200 kcfs for two days this season.

Spill

The project spilled water for a few days at the end of March and from 7 April through June 21 and for the two weeks in July (for the SBC) (Table 1). Spill occurred at the project a total of 98 days and peaked at 111.1 kcfs on 28 May (Figure 1 and Appendix 1,Table 1). Spill for fish passage took place primary in April and late June between 0000 hours and 1200 hours to accommodate surface collector testing. Surface collector discharge through spillbay 1, along with accompanying discharge from spillbay 2, occurred nearly continuously when the surface collector was in operation from mid-April through May and during the month of July. This discharge was generally between 4.3 and 6.2 kcfs and was shut off during gate setting changes and for maintenance. Flows in excess of turbine capacity provided 24 hour per day spill for 76 days between 7 April and 21 June.

Water temperature

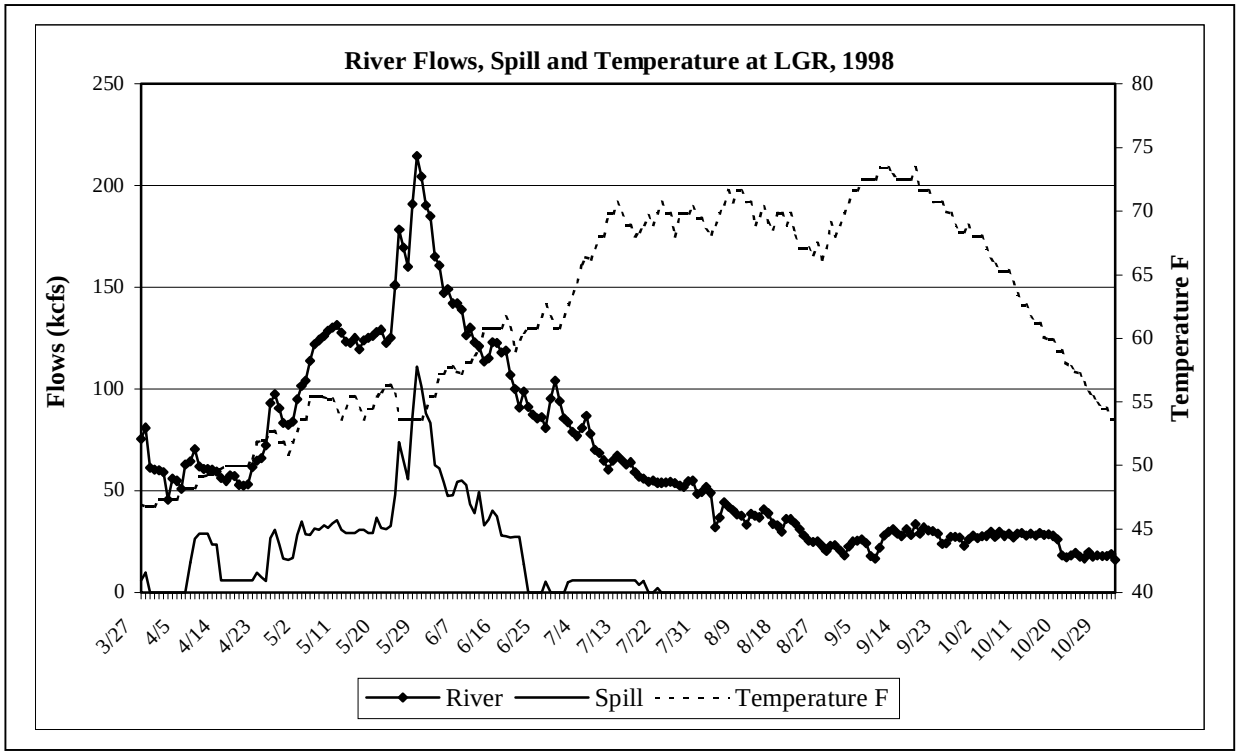
Facility water temperatures were near 47° F at the start of the season in late March and remained below 60° F until 11 June (Appendix 1, Table 1). The water temperature was below 65°F until 3 July, reached 70° F on 10 July and peaked at 72.5-73.0° F between 5 and 17 September. Facility water temperatures then decreased to below 70° F on 25 September, 65° F on 9 October and 60° F on 18 October. The temperature at the end of the season on 1 November was 54° F.

From April 1 through November 1, 1998, temperature units (tu's), the number of Fahrenheit degrees above 32º F, totaled 6,436. The number of temperature units for the same period in 1997 and 1996 were 6,046 and 5,922, respectively. Temperature unit totals in 1998 increased 4.7% over the average for the last three years. Water temperatures in 1998 during the spring/summer migration period, April 1 to June 20, were 9% warmer based on tu totals for the same period in 1997 (1,776 in 1998 and 1,600 in 1997). Temperature unit totals during the spring/summer migration period, June 1 to November 1, in 1998 were 4% warmer than in 1997 (4,659 in 1998 and 4,468 in 1997). The average water temperature was 1.3º F higher in 1998 between August and September than in 1997.

Table 1. Comparison of average monthly river flow and spill at Lower Granite Dam, 1994-1998.

Month	1994	1995	1996	1997	1998	1993-1998 Average
			Flow (kcfs)			
Apr	51.0	60.1	112.6	120.9	64.8	81.5
May	77.5	107.9	126.2	168.5	139.3	123.9
Jun	39.3	115.6	146.2	162.8	115.4	115.8
Jul	39.4	62.0	55.4	69.8	62.4	57.8
Aug	13.0	37.4	37.6	46.9	33.7	33.7
Sep	13.4	27.4	25.0	29.6	26.4	24.4
Oct	17.5	28.0	22.2	40.5	24.3	26.5
			Spill (kcfs)			
Apr	0.0	0.0	47.0	27.2	12.7	17.4
May	15.7	18.4	47.0	58.5	45.1	36.9
Jun	7.9	9.3	52.6	62.1	29.0	32.1
Jul	0.0	0.0	3.4	3.3	3.3	2.0
Aug	0.0	0.0	0.1	0.6	0.0	0.2
Sep	0.0	0.0	0.0	1.5	0.0	0.2
Oct	0.0	0.0	0.0	0.2	0.0	0.0

Figure 1. Snake River flow, spill and temperature at Lower Granite Dam, 1998.



Debris

Organic debris accumulations in the fish facility again presented significant challenges this season. As is typical during relatively high runoff seasons, large amounts of weeds, sticks, branches and trees showed up in the forebay. At times this season, the effects of debris in the fish facility were severe. However, debris volumes in 1998 were considered less than those in 1997. Runoff water in 1997 was the highest of the previous four years and large amounts of woody debris accumulated on the banks of streams and rivers over this time were washed downstream. The larger runoff of 1997 likely reduced the impact of woody debris in the fish facility in 1998. Woody debris loads in the fish facility were monitored during the season by measuring daily sample tank accumulations and by reporting trash rack raking and forebay debris removal events.

Debris in the fish facility is problematic because it can effect fish condition, detectable in descaling and mortality rates, and the accuracy of accounting for facility mortalities. Large amounts of debris in the raceways obscure smolt mortalities because they become mixed with the debris. Debris further complicates fish distribution from the separator when it causes plugs in the sample pipe, the direct-load barge line and the barge and truck load lines from the raceways. Debris problems also commonly cause problems in keeping the orifices in the collection gallery clear and free of plugs.

This is the first year that we've measured the volume of debris removed from the sample tank daily. Every day before we began sampling fish, the woody debris was netted out and placed in a 32-gallon trash can (4 ft^3). The volume was estimated and recorded. The daily volumes of debris collected from the sample tank in 1998 are presented in figure 2.

The woody debris removed from the sample tank during the season was composed of material varying widely in size but generally small enough to fit through the two-inch wide spaces between the parallel bars of the separator. Larger material that accumulated on the separator was released back to the river over the separator's tail screen. Woody debris released into the river off the separator was not quantified and no estimates of volume were made. The smaller debris that passed through the separator during the season accumulated in the raceways and sample tank. Estimates of daily sample tank debris help provide a relative measure of the amount of small debris that passes through the separator and impacts fish in the sample tanks and raceways.

We removed an estimated total of 150 cubic feet of debris from the sample tank in 1998. Daily accumulation during the season averaged 0.7 cubic feet of debris per day. We used the daily sample rates to estimate the total accumulation of small debris in the facility including raceways and sample. Based on the daily sample rates, a total of 939 cubic feet of small woody debris passed through the fish facility during the season. Total daily debris accumulations averaged 4.3 cubic feet per day in 1998. Debris levels in the facility were highest during the season between May 27 and July 2 when daily average debris totals ranged between 5 and 55 cubic feet of material per day (Figure 3). During this period, average daily flows peaked at 213 kcfs and then decreased to about 70 kcfs. This was also the time when most of the debris related problems occurred at the fish facility including the collection gallery orifices, dewatering screen

and sample line blockages. Debris accumulations in the raceways slowed down the work of loading fish into trucks and barges and occasionally caused blockages in barge and truck lines. Facility debris levels were relatively light prior to the peak in river flows. Between April 7 and May 27 when fish counts were high and the sample rate was at the minimum of 0.67%, facility debris levels ranged between 0.5 and 5 cubic feet per day. Once flows peaked on May 25, debris in the facility was prevalent until July 31 and then decreased sharply for the remainder of the season.

Debris buildup on trash racks in front of turbine units 1, 5 and 6 eventually created head differentials in the gatewell slots, lowering water levels in the gatewells below the collection orifices. This condition was discovered on June 4 when collection gallery orifices in the effected units were found to be drawing air. Trash racks on all units were raked between June 5 and 9 because of this. Four full truckloads of large woody debris were removed from trash racks in units 5 and 6. The total volume of debris removed from all trash racks was not available. Debris removal from trash racks of turbine unit 1 reportedly took the longest of all six units. One full day was required to rake trash racks in unit 1. Turbine unit 1 had extra debris on the trash rack because on April 8, when trash racks of turbine unit 3 were raked to prepare for the installation of the BGS, the debris truck was not available and the debris was simply dumped in front of unit 1. Trash rack raking requires the turbine units to be taken off-line (shut off) during the procedure. Though most of the larger debris material was removed, much of the smaller debris material remained near the turbine unit intake area. When the units were restarted, large amounts of small woody debris were recorded in the fish facility. After restarting turbine units 1 and 4, large amounts of small woody debris caused plugs in the sample line and the dewatering screen. The sample system was shut down for two hours as debris passed and was removed.

Activities related to the surface bypass collector and the behavioral guidance structure often contributed to sharp increases of debris in the fish facility during the season. On April 15, movement of the BGS apparently caused a mass of woody debris that had accumulated near the south end of the surface collector to get drawn into the fish facility. The surge of debris mostly ended up in raceway 8 where NMFS researchers were collecting fish for a PIT-tag marking program. The large amount of debris in the raceway caused NMFS markers to reject all the fish in raceway 8 for marking.

On June 24, a surge of debris into the facility was recorded following the reinstallation of the false-bottom structures known as "component-B units". These structures provide a barrier between the bottom of the surface collector and the face of the dam and were replaced on June 23. Debris floating on the surface between the SBC and the dam was apparently pushed down and into the turbine intakes. Facility debris following the event increased from about seven cubic feet of debris on June 23 to 47 cubic feet on June 24. Increased mortality rates and chronic debris problems in the fish facility occurred for two days following the reinstallation of the component-B units.

Forebay debris removal was conducted on June 29 and 30. Approximately two acres of large floating woody debris was towed from in front of the forebay shear boom to the north bank of the river. This event resulted in an increase of small woody debris accumulations in the fish facility for several days that peaked at 16 cubic feet on July 1. Removing the large raft of

floating forebay debris however significantly improved debris conditions in the facility for the rest of the season. By July 3, daily average debris levels in the facility were less than 0.5 cubic feet of material.

Figure 2. Daily sample tank debris accumulations at LGR, 1998

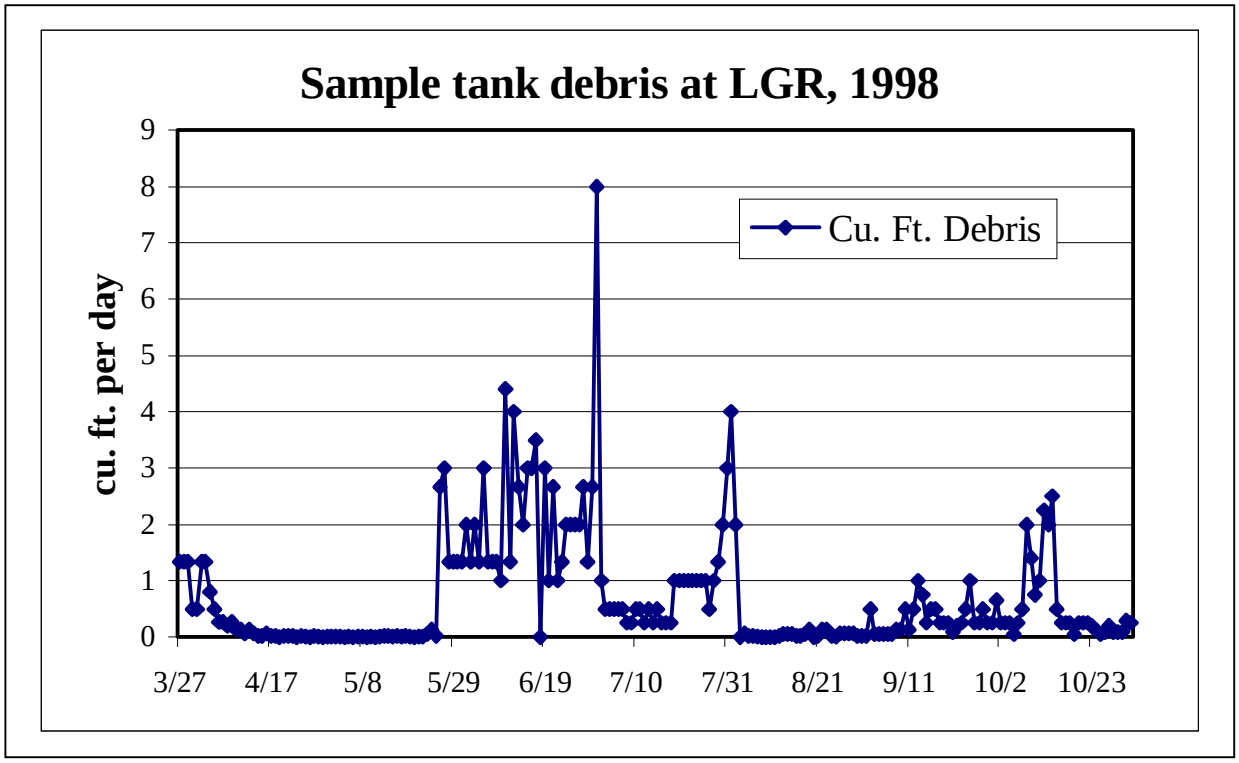
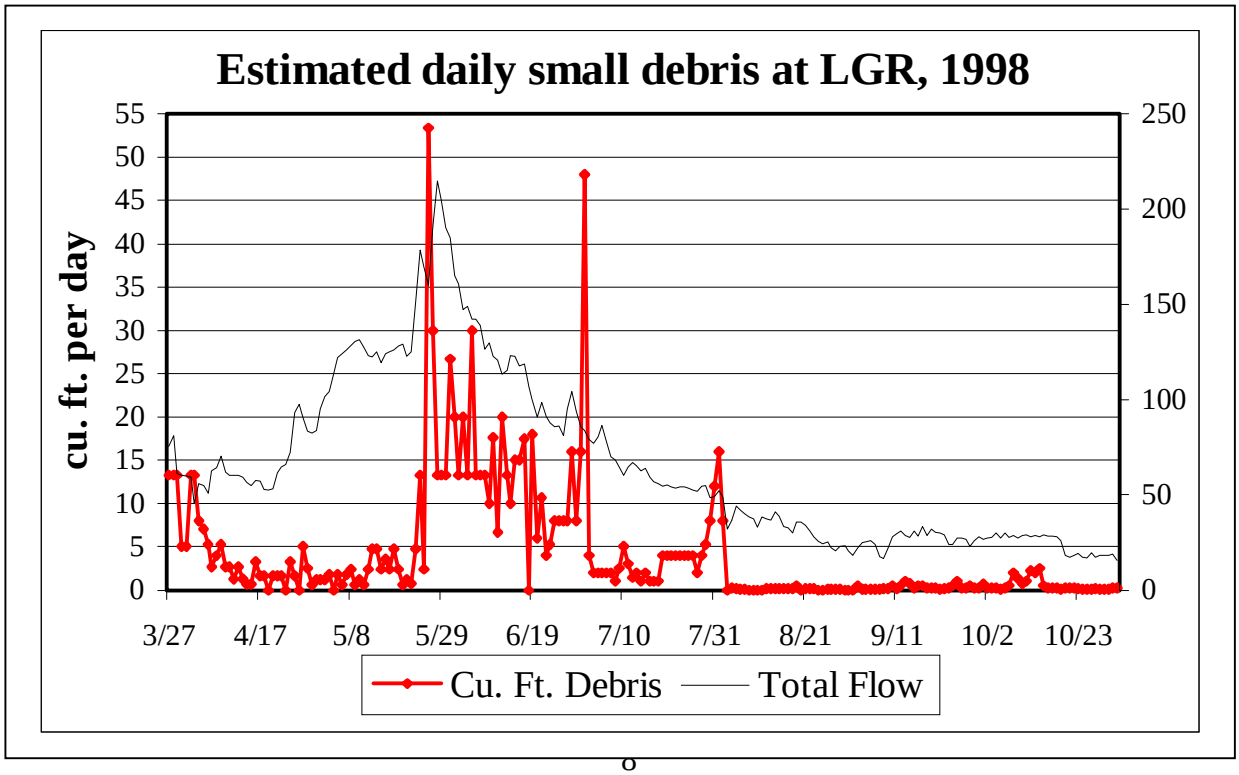


Figure 3. Daily estimated small woody debris accumulations at LGR, 1998



Turbidity

We used a secchi disc to measure turbidity during the season in the adult fish ladder at Lower Granite. Visibility readings gave us a relative measure of turbidity. When loads of suspended solid particle materials in the river increased, visibility through the water decreased. Measurements were taken from the surface of the fish ladder adjacent to the adult fish viewing windows. We used a six-inch black and white disk attached to the end of a two-meter rod with graduations in tenths of feet. Most measurements were taken at about the same time of day every day between 10 A.M. and noon. Surface water conditions at the measurement location were generally flowing and rippled and together with varying lighting conditions may have decreased the accuracy of individual measurements somewhat. Shallower readings were easier to take accurately than deep ones.

We observed several relatively sharp decreases in visibility in the river this season. The largest decrease in visibility occurred during peak flows of the main spring runoff period between May 24 and June 5 (Figure 4). Visibility during this period was generally less than one foot. Low visibility in the river during this period corresponded with peak season collection counts (May 27) followed by rapidly decreasing counts of yearling chinook and steelhead Subsequent decreases in visibility corresponded with storm events in the region during the summer. Two storms in early July resulted in nearly two-foot decreases in visibility. Visibility decreased from three feet on July 6 to about 0.7 feet on July 7 and again from nearly three feet on July 10 to 1.1 foot on July 11. These storm caused drops in visibility corresponded to sharp increases in wild subyearling chinook collections at the fish facility (Figure 5). Subyearling chinook counts increased during this period from less than 1,000 fish per day on July 4 to more than 6,000 on July 9 and 2,600 fish on July 15. Visibility in late July and for the rest of the season ranged between three and five feet and did not appear to appreciably effect daily fish counts.

Figure 4. Fish ladder visibility and river flows at LGR, 1998

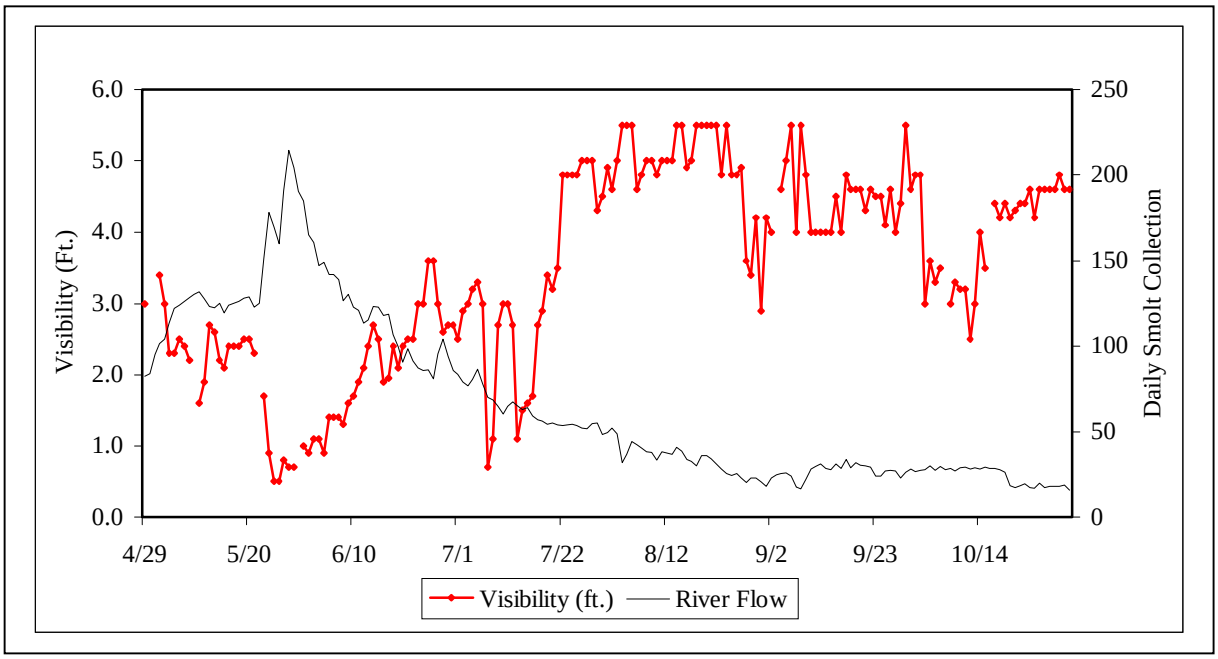
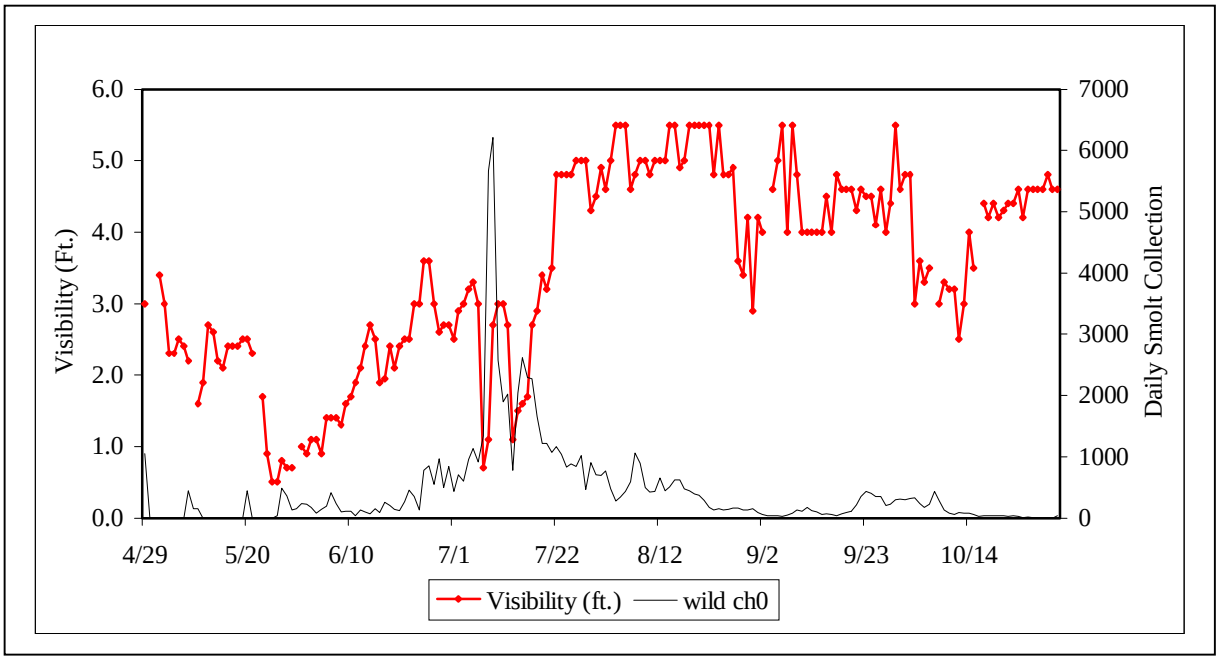


Figure 5. Fish ladder visibility and wild subyearling chinook collection at LGR, 1998



Sample Program and Summary

Overview

Daily samples of fish from the general collection were counted by hand and examined throughout the season. Sample data including counts by species, weight and descaling data were recorded and summarized daily to provide real time information for the Smolt Monitoring Program and for the Corps of Engineers transportation program. Daily samples were collected over a 24-hour period between 7 a.m. and 7 a.m. and processed between 7:30 and 10 A.M. each day. In the latter part of the season when the mini-tanker was used to transport fish (after total fish weights decreased below 75 pounds) daily samples were processed every-other-day on transport days. Throughout most of the season, researchers taking advantage of the availability of anesthetized fish in the sample took some fish for marking and study purposes. We sampled a total of 124,741 smolts, 1.8% of the total collection this season. Daily sample sizes averaged 567 fish for the season and ranged between 14 and 3,263 fish.

The PIT-tag diversion system operated throughout the season diverting tagged fish passing through the separator to the bypass outfall pipe and/or raceways. Between March 27 and June 10 the system automatically bypassed one out of four PIT-tagged hatchery yearling chinook tagged for the Fish Passage Center hatchery chinook PIT-tag study and all other PIT-tagged fish except those exiting the separator when the sample gate was open. From June 10 through November 1 the PIT-tag system was set to overide the sample slidegate and also bypass tagged fish that would have otherwise been diverted to the sample.

Daily sample procedure

Fish diverted to the sample tank were held for up to 24 hours prior to examination. The 24-hour sample period started at 7 a.m. At the end of each 24-hour sampling period, the entire sample was processed. Small groups of fish were separated into batches as follows: screens in the sample holding tank were moved forward to crowd fish to the front of the tank. Once there, small groups of fish were drawn/guided into the pre-anesthetic chambers by opening and closing the knife gates. Batch sizes typically ranged between 30 and 60 fish per chamber and the number of fish was adjusted based on the amount of time the gate was opened and the position of the crowder screen. The fish tranquilizer, ethyl *m*-aminobenzoate methansulfonate (MS-222®), was added to the chamber to obtain a concentration of about 62 mg/l. At this concentration, about 95 percent of the fish were adequately sedated within three minutes. Once anesthetized, these fish are flushed through the exit valve on down to the sorting tank.

The sorting tank is part of a re-circulating anesthetic system with water temperature control and aeration. The anesthetic levels in the system are set to keep fish sedated and easy to handle during the sample. Typically the MS-222 levels averaged between 55-60 mg/L. Sample fish remained in the sorting tank for as little as five seconds and up to five minutes. We strive to process fish within three minutes of entering the tank to minimize the effects of sedation and handling as much as possible. Between the pre-anesthetic chambers and the sorting tank, sample fish were sedated an average of five minutes.

All fish handled in the sorting tank were enumerated by species and examined for unique marks and descaling. Additionally, a detailed sub-sample of up to 100 fish of each species was conducted during each daily sample. The detailed sub-sample recorded species, length, weight, unique marks, descaling, injuries and external symptoms of disease. In this process, fish were individually weighed and measured in a water-filled tray on an electronic balance. This detailed sub-sample provides the Corps with fish per pound and species composition data essential for the Corps biologist to calculate raceway, barge and truck loading densities and stay within the maximum loading densities of 0.5 pounds of fish for every gallon of water. Immediately after handling, fish were routed in fresh water to the recovery tank on non-transport days or routed directly onto a waiting truck or barge on transport days. The maximum time that any fish was held at the fish facility was 48 hours.

Sample rates

An automatic timer is used to set the number and length of time the slide gates open each hour to divert fish to the sample holding tank. This timer enables the COE to adjust the sample rates. The COE biologist adjusts the timers during the season based on the SMP Sample Rates Guideline Table (Table 2), on daily trends in total collection estimates, and to meet researcher needs. Sample rates were adjusted throughout the season to achieve daily sample sizes of between 500 and 1,000 smolts whenever practical. When daily total collection counts exceeded 80,000 fish, the minimum sample rate setting of 0.0067 (0.67%) was employed. Daily samples were taken at this rate for a twenty-five day period between April 27 and May 21. During this time sample sizes ranged from 800 to more than 3,000 fish (Figure 6).

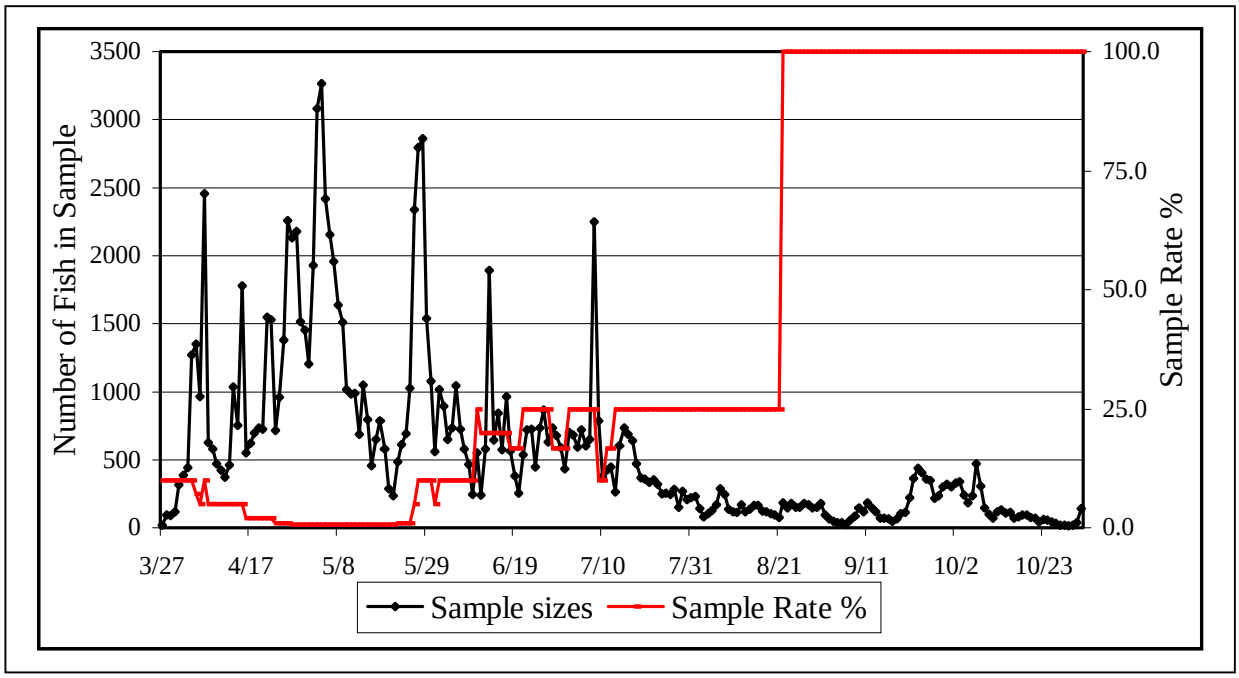
Sample sizes exceeded 1,000 fish on ten days between March 27 and April 26 as daily collection counts increased and the sample rate was gradually reduced to the minimum rate of 0.67%. While the sample rate was set on the minimum, samples sizes exceeded 1,000 fish for fifteen days. The sample rate was increased to exceed recommended guidelines between May 26 and June 5 to accommodate NMFS research. During this period, sample sizes exceeded 1,000 fish for seven days. We estimated that an additional 1,943 smolts including 120 wild subyearling chinook were sampled to meet NMFS research needs. After returning to guideline sample rates on June 6, there were only two more days when sample sizes exceeded guideline criteria when incoming fish numbers increased unexpectedly. On August 22, after collection totals dropped to less than five hundred fish for five consecutive days the sample rate was increased to 100% and all incoming fish were routed to the sample tank.

Table 2. Lower Granite Dam Juvenile Fish Facility sample rate guidelines.

Daily Collection	Sample rate	Gate activations and durations per hour**	Number of fish In sample
>80,000	0.67%	3 @ 8 seconds	536 plus
60,000 - 80,000	1.00%	3 @ 12 seconds	600 - 8,00
40,000 - 59,999	1.33%	4 @ 12 seconds	532 - 800
25,000 - 39,999	2.00%	6 @ 12 seconds	500 - 780
15,000 - 24,999	3.33%	10 @ 12 seconds	500 - 832
10,000 - 14,999	5.00%	10 @ 18 seconds	500 - 750
7,500 - 9,999	6.67%	10 @ 24 seconds	500 - 667
5,000 - 7,499	10.00%	10 @ 36 seconds	500 - 750
2,500 - 4,999	16.67%	10 @ 1 minute	417 - 833
500 – 2,499	25.00%	10 @ 1.5 minutes	125 - 625
<500	100%	Gate open	ALL

**This column refers to the number of times the sample slidegate opens in an hour. For instance the first set of numbers means the slidegate will open 3 times for 8 seconds each time for every hour of a 24-hour sampling period.

Figure 6. Number of smolts in the sample and sample rates by day at LGR, 1998



Season sample summary

A total of 124,741 smolts, 1.8% of the collection, were sampled in 1998 between April 27 and Nov 1. Daily sample sizes averaged 567 smolts for the season and ranged between 14 and 3,263 fish. Most of the fish from daily samples were transported following the sampling procedure. A total of 7,849 sample fish, 6% of the season sample, were bypassed for various reasons during the season. The majority of these fish were bypassed after tagging for research projects.

A total of 1,692 sample fish were bypassed during the season in addition to fish bypassed for research. On April 6 and 7, a total of 1,010 smolts were bypassed because of lack of truck space, including: 422 hatchery yearling chinook, 383 wild yearling chinook, 159 hatchery steelhead and 46 wild steelhead. Between September 21 and 25 a total of 523 wild subyearling chinook were bypassed from the sample because of a lack in mini-tanker truck availability. Radio tagged fish from the sample were bypassed to the river at the request of researchers. Between April 22 and June 14, four hatchery yearling chinook and 7 hatchery steelhead with radio tags were bypassed. A total of 21 wild subyearling chinook with radio tags were bypassed from the sample between July 3 and August 26. These fall chinook were originally collected from previous daily samples and tagged for release above LGR. On June 11, three hatchery steelhead were mistakenly sent down the wrong pipe and were bypassed. Starting on August 24 steelhead and coho were bypassed because they were considered non-smolts that had lost their migratory characteristics and were likely to residualize. Between August 24 and November 1 a total of 124 fish were bypassed for this reason, including: 18 hatchery steelhead, 58 wild steelhead and 48 coho.

Four different agencies conducted seven studies using fish from daily samples. During the sample season, researchers handled 7,340 smolts from the daily samples (Table 3). Of the 6,866 sample fish tagged by researchers, 6,157 fish (89.7%) were subsequently bypassed, including: 2,103 hatchery yearling chinook, 506 wild yearling chinook, 391 wild subyearling chinook, 2,709 hatchery steelhead and 446 wild steelhead. NMFS PIT-tagged fish from the sample for three studies: the transportation study from May 27 to June 30, tagging 1,010 yearling chinook; the reach survival study from May 27 to June 6, tagging 3,155 steelhead; and the LGO project survival study, April 29 to May 17, tagging 1,599 hatchery yearling chinook. Researchers with USFWS examined 68 yearling chinook between March 30 and April 4 for a fall chinook study. Researchers with the University of Idaho sacrificed 236 yearling chinook and 61 steelhead for a smolt condition study. And, researchers with USFW-BRD radio-tagged smolts for two studies: the temperature tag study between July 10 and September 9, tagging 97 wild subyearling chinook; and, the summer SBC study between July 2 and July 10, tagging 294 wild subyearling chinook. Additional details of these and other research activities conducted at LGR in 1998 are provided in the research section of this report.

Table 3. Total number of fish taken from daily samples for research needs at LGR, 1998.

	Yearling Chinook		Subyearling[1] Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Total
Tagged	2,413	907	0	391	2,709	446	0	0	0	6,866
Examined	7	61	0	0	0	0	0	0	0	68
Sacrificed	196	40	0	0	31	30	0	0	0	297
Handled	0	14	0	76	0	0	1	0	0	91
Mortality	4	5	0	9	0	0	0	0	0	18
Total	2,620	1,027	0	476	2,740	476	1	0	0	7,340

Overall, we sampled fewer fish this season compared to 1997, however the percentage of hatchery and wild yearling chinook sampled increased (Table 4). Most species were sampled at a rate that was similar to the average over the past four years. Wild subyearling chinook were sampled at a higher rate than other species because their migration timing through the summer exposes them to higher sample rates. In 1998, nearly 30% of the fall chinook smolts collected at the facility were sampled. That's down about 4.5% from the five-year average of 34.5%. Weekly sample totals and sample rates are provided in Table 5.

Table 4. Annual percentage of juvenile salmonids sampled from the total collection at Lower Granite Dam, 1994-1998.

	Yearling Chinook		Subyearling[1] Chinook		Steelhead		Sockeye/Kokanee[2]		Coho[3]	
Year	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Total
1994	1.4	3.5	---	36.9	2.1	2.2	---	6.3	---	2.0
1995	1.0	2.4	---	28.7	1.0	1.3	10.0	9.8	---	1.2
1996	1.5	2.5	---	38.5	1.7	2.6	7.4	9.7	8.4	1.9
1997	1.3	1.7	26.9	38.3	1.5	1.6	7.1	36.3	6.9	2.0
1998	1.4	2.5	14.0	29.9	1.3	1.6	2.0	4.1	2.7	1.8

[1]Hatchery subyearling chinook were not present until 1997.
[2]Hatchery sockeye/kokanee were not present until 1995.
[3]Hatchery coho were not present until 1996.

Table 5. Sample rates (%) and number of salmonids sampled by week at Lower Granite Dam, 1998.

Week Ending	Weekly Rate (%)[1]	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
		Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Totals
2-Apr	10.00	212	139	0	3	351	747	0	1	10	1,463
9-Apr	7.05	1,760	1,679	0	3	3,187	1,104	0	0	5	7,738
16-Apr	4.31	2,030	811	0	2	2,184	359	0	0	4	5,390
23-Apr	1.80	3,537	726	0	0	1,994	317	0	0	3	6,577
30-Apr	0.77	3,304	426	0	8	6,895	1,233	0	0	17	11,883
7-May	0.67	2,748	511	0	0	11,648	965	22	0	125	16,019
14-May	0.67	1,141	246	0	5	5,375	627	174	3	309	7,880
21-May	0.67	220	81	0	3	2,866	287	74	3	268	3,802
28-May	2.80	328	320	0	87	7,638	1,416	191	4	835	10,819
4-Jun	9.16	93	89	19	102	4,962	690	78	2	449	6,484
11-Jun	11.23	70	73	16	141	2,808	357	82	0	309	3,856
18-Jun	19.45	193	235	27	193	4,570	423	122	0	307	6,070
25-Jun	22.72	382	464	11	541	2,000	128	103	0	175	3,804
2-Jul	19.67	449	375	0	982	2,462	94	70	1	210	4,643
9-Jul	21.05	488	727	0	3,276	1,199	44	26	2	530	6,292
16-Jul	19.49	73	14	0	2,844	272	9	11	1	324	3,548
23-Jul	25.00	75	47	0	2,412	177	14	3	0	125	2,853
30-Jul	25.00	58	28	0	1,412	100	3	3	0	53	1,657
6-Aug	25.00	75	37	0	894	57	4	3	0	5	1,075
13-Aug	25.00	46	15	0	1,105	17	3	0	0	7	1,193
20-Aug	25.00	19	18	0	859	4	3	0	0	2	905
27-Aug	82.18	52	15	0	975	7	2	1	1	12	1,065
3-Sep	100.00	35	19	0	771	1	5	0	3	15	849
10-Sep	100.00	32	6	0	448	2	4	0	1	13	506
17-Sep	100.00	30	11	0	631	3	4	1	0	21	701
24-Sep	100.00	22	15	0	1,663	4	3	0	1	12	1,720
1-Oct	100.00	28	2	0	2,032	3	9	0	0	11	2,085
8-Oct	100.00	60	6	0	2,012	0	13	0	2	16	2,109
15-Oct	100.00	180	5	0	577	2	9	0	0	11	784
22-Oct	100.00	273	12	0	224	0	7	10	1	2	529
29-Oct	100.00	133	4	0	92	0	3	4	0	10	246
1-Nov	100.00	113	7	0	49	1	8	3	0	15	196
Season Total		18,259	7,163	73	24,346	60,789	8,894	981	26	4,210	124,741
% of Sample		14.6%	5.7%	0.1%	19.5%	48.7%	7.1%	0.8%	<0.1%	3.4%	100.0%
% of Collection		1.4%	2.5%	14.0%	29.9%	1.3%	1.6%	2.0%	4.1%	2.7%	1.8%

[1] Fish sampled/fish collected X 100%.

Mark Recaptures

External hatchery marks including freeze brands, elastomer color-code implants (VIE) and fin clips, were recorded during daily SMP and GBT samples. Recapture data for all externally marked smolts in the sample was reported to the Fish Passage Center daily throughout the season. PIT-tag codes were recorded from tagged fish encountered in GBT samples and from daily facility mortalities. Tagging files with PIT-tag codes flagged with RE for recaptured fish and M for mortalities were submitted to PTAGIS. Fin clips including adipose and or ventral fin clips were typical on most hatchery origin chinook and steelhead. Hatchery summer chinook from McCall were marked with left-green elastomer implants and no clips. Approximately 83,000 subyearling hatchery fall chinook released above LGR were unclipped but 100% PIT-tagged and most were automatically bypassed to the river.

Marked fish from numerous releases above LGR entered the fish facility during the sampling season. These fish were raised by three different hatcheries for the following agencies: USFWS, WDFW, IDFG, ODFW, and the Nez Perce Tribe. This year, the releases included 90,000 hatchery steelhead with freeze brands, 24,900 summer and 336,191 fall yearling chinook with VIE tags. A total of 1,023 VIE tagged fish and 121 branded fish were recorded in daily samples during the season. Based on daily sample rates, an estimated 117,283 marked fish entered the collection facility at LGR (Table 6).

Table 6. Number of hatchery steelhead and chinook marked and released above LGR and the estimated total numbers and percent of each marked group collected at LGR, 1998.

Mark Code[1]	Rearing type & Species	Race	Hatchery	Release Site	RKm To LGR	Total Released	Total Recaptured	Percent Recovered
FB-RA-IJ-1	H. Steelhead	SU	Lyons Ferry	Grand Ronde R	144	25,000	6,050	24.2%
FB-RA-IJ-3	H. Steelhead	SU	Lyons Ferry	Grand Ronde R	144	25,000	9,165	36.7%
FB-LA-T-1	H. Steelhead	SU	Dworshak	N.F. Clearwater R.	116	10,000	150	1.5%
FB-RD-T-1	H. Steelhead	SU	Dworshak	N.F. Clearwater R.	116	10,000	0	0.0%
FB-LD-T-3	H. Steelhead	SU	Dworshak	N.F. Clearwater R.	116	10,000	0	0.0%
FB-RA-T-3	H. Steelhead	SU	Dworshak	N.F. Clearwater R.	116	10,000	150	1.5%
EL-LGR, No Clip	H. Chinook	SU	McCall	S.F. Salmon R.	345	24,900	576	2.3%
EL-LGR	H. Chinook	FA	Lyons Ferry	Big Canyon Clearwater R.	110	61,472	17,417	28.5%
EL-RGR	H. Chinook	FA	Lyons Ferry	Pittsburgh L. Snake R.	390	141,814	46,360	32.7%
EL-LBL	H. Chinook	FA	Lyons Ferry	Cpt. John A.P. Snake R	90	133,205	37,415	28.1%

[1]Mark Codes: FB = freeze brands (location, brand, orientation); EL = elastomer tags (side, color).
Table does not include GBT marked fish

Fish from most marked release groups were observed in the sample at LGR between six and nine days from the first release date (Table 7). We observed very few Dworshak hatchery steelhead marked with T-brands and released between April 29 and May 8. This may reflect low sample rates, spill, and large numbers of fish in the daily collections.

Travel times to first observation in the sample for elastomer-marked hatchery yearling fall chinook released the first two weeks of April ranged from 18 to 20 days. Hatchery yearling summer chinook released in the Salmon River took 38 days to first appear in daily samples.

Table 7. Passage dates of marked hatchery steelhead and chinook collected at Lower Granite Dam in 1998.

Mark Code	Species, run & rear type	Total Obs.	Release Date	First Observed	25%	50%	75%	Last Observed
FB-RA-IJ-1	H.ST, SU	48	Apr 1-15	Apr 8	Apr 27	Apr 30	May 5	May 31
FB-RA-IJ-3	H.ST, SU	71	Apr 15-30	Apr 22	Apr 27	Apr 28	Apr 30	Jun 13
FB-LA-T-1	H.ST, SU	1	Apr 29-May 8	May 5	---	---	---	May 5
FB-RD-T-1	H.ST, SU	0	Apr 29-May 8	---	---	---	---	---
FB-LD-T-3	H.ST, SU	0	Apr 29-May 8	---	---	---	---	---
FB-RA-T-3	H.ST, SU	1	Apr 29-May 8	May 8	---	---	---	May 8
EL-LGR, nc	H.CH1, SU	21	Apr 1-15	May 8	May 8	May 14	May 17	July 10
EL-LGR	H.CH1, FA	165	Apr 1-15	Apr 21	Apr 26	May 1	May 4	July 10
EL-RGR	H.CH1, FA	469	Apr 1-15	Apr 19	Apr 24	Apr 26	Apr 30	May 14
EL-LBL	H.CH1, FA	53	Apr 1-15	Apr 20	Apr 24	Apr 26	May 2	May 13

[1]Mark Codes: FB = freeze brands (location, brand, orientation); EL = elastomer tags (side, color). No fin clip, nc. Table does not include GBT marked fish

Marked fish captured off the separator for GBT examinations were reported to FPC. Fish removed from the separator were sampled at 100% and their tally added to the total collection. A total of 139 elastomer tagged yearling chinook were recorded during GBT examinations, including: 7 left-green no clip, 28 left-green, 51 right-green, 53 left-blue and one right-blue elastomer tags. Additionally, four freeze-branded steelhead were recaptured off the separator for GBT.

Twenty-four jack chinook recorded in daily samples were elastomer tagged, including one left-blue, two left-green, 17 left-orange and four right-green elastomer marked fish. Mark data for these adult fish was recorded but not required by FPC. Eight of the jacks were also marked with a double-hole punch in the left operculum plate. Marked fallback sample data including, sample dates, fish lengths, eye tags, and fish condition was reported to the NMFS Adult Monitoring Project at LGR. Jacks collected in the sample were released to the river off the barge dock after recovering from anesthetic.

We scanned fish taken from the separator and fish mortalities from the facility for the presence of PIT tags. Facility mortalities from raceway were scanned except for steelhead between April and mid-May. Sample fish were not generally scanned for PIT tags because PIT-tag detectors in the sample pipe near the separator were recording them. PIT-tag data was

collected and reported to the Columbia River Basin PIT-Tag Information System (PTAGIS) in the tagging file format. In previous years, PIT-tagged mortality fish were reported to PTAGIS in the form of mortality files. PTAGIS has requested that we instead use only the tagging file type and include codes for recapture (RE) and mortality (M) for each record.

We scanned fish removed from the separator for the GBT exams for PIT tags between April 7 and June 30. PIT-tagged fish were not examined but placed in fresh water and allowed to recover from anesthesia. At total of 157 PIT-tagged fish were netted from the separator during this project: 133 hatchery yearling chinook, 10 wild yearling chinook, 9 hatchery steelhead, 4 wild steelhead and 1 coho. PIT-tag codes were stored in the scanner and recorded on a form with species, rearing type and hatchery mark information. PIT-tagged fish were returned to the separator after recovering from the anesthetic. After each GBT day, the codes stored in the scanner were downloaded to a temporary computer file, and later assembled in a PTAGIS tagging file. Daily records were saved up until several could be combined into one tagging file. We submitted 25 files for inclusion in the PTAGIS database.

We scanned all dead fish from daily samples and from the raceways, except steelhead between April 1 and May 21. PIT tag mortality information, including tag code, species, rearing type, recapture code and mortality code were entered into a PTAGIS tagging file. A total of 117 dead fish were found to have PIT tags in them, including: 94 hatchery yearling chinook, 9 wild yearling chinook, 11 wild subyearling chinook, 2 hatchery steelhead and 1 hatchery sockeye. PIT-tag mortality records were collected periodically into a tagging file. Tagged mortalities were reported to PTAGIS in 14 files during the season. The PIT tags were recovered and mailed to the Pittag Operations Center at the end of the season.

Seventeen radio tagged wild subyearling chinook encountered in daily samples during the season were recorded on a special form. A total of 17 radio-tagged were recorded. These fish were part of a telemetry study conducted by USGS-BRD and were originally taken from previous daily samples and tagged for release above LGR. We recorded individual fish data including, species, rearing type, length, weight, and suture condition on forms provided by USGS-BRD. These forms were forwarded to the Columbia River Research Laboratory in Cook, Washington. All radio tagged fish were allowed to recover from anesthetic in fresh water and released off the barge dock. One tagged fish was a mortality and its radio transmitter removed and deactivated.

Sample procedures for Gas Bubble Trauma (GBT)

Sampling methods to identify levels of dissolved gas in juvenile salmonids have undergone continuous review since the program started in 1994. Current sampling methods and protocol are based on research conducted by fish physiologists and health specialists/pathologists with the United States Geological Survey, Biological Research Division (USGS-BRD) based at the Columbia River lab at Cook, WA. Fish Passage Center staff have actively guided and participated in this process. BRD staff have conducted training sessions at the beginning of each season for the past four years. Staff from Lower Granite Dam attended this season's GBT training seminar at the Cook lab on March 26 and 27 where fish handling methods, examination

techniques, and data handling protocols were reviewed and demonstrated. Site specific sample protocols at Lower Granite called for us to examine 100 yearling chinook and 100 steelhead, hatchery or wild, every other day, Monday, Wednesday and Friday between April and June.

Fish for GBT samples were netted from the open flume just ahead of the separator bars where fish would be diverted to the raceways or sample tank via sample gates and flumes. Staff would net and collect fish, individually, either steelhead or chinook, and place them in a dark, five-gallon bucket with 10 liters of water with MS-222® at 30mg/l. Once they had collected seven fish they would carry the bucket and fish downstairs to the GBT lab located next to the separator. The time required to net seven fish varied due to fish availability but generally took about five minutes. In the GBT lab, one fish at a time would be removed from the capture bucket and scanned for the presence of a PIT tag. If a tag was detected, the code was recorded and this fish returned to a bucket containing fresh water. The tagged fish was allowed to recover and released back into the separator. Later all PIT tag codes were entered into a PTAGIS recapture file. If no PIT tag was detected the fish was placed in a bucket with water and MS-222® at 80 mg/l to fully sedate the fish for the detailed examination. Once fully sedated this fish was placed in an examination tray equipped with hoses that provided flowing water with 30 mg/L of MS-222® directly to the mouth and over the gills throughout the examination. Another fish was then scanned for a PIT tag and if not tagged, placed in the bucket of water with 80 mg/l MS-222®. Staff then carefully examined the left lateral line, unpaired fins and both sides of the head on the fish in the examination tray for bubbles associated with GBT using a stereo microscope. The examiner recorded species, origin, fork length, presence or absence of bubbles, and the time at the start of the exam. The sampled fish was then placed in a bucket of freshwater with aeration and allowed to recover before it was released into a raceway. It took about 1.5 minutes to complete each examination. At the end of the day, sample data were transcribed to a database on a spreadsheet and transmitted to FPC. Those fish sampled for GBT symptoms were placed in a raceway to prevent them from being diverted to the sample tank and sampled again. These fish were treated and recorded as a separate sample with a sample rate of 100% and their numbers added to the following day's collection totals.

GBT sample summary

Smolts were netted from the separator between April 7 and June 30 this season. We examined a total of 5,695 smolts for symptoms of GBT including, 1,649 hatchery yearling chinook, 442 wild yearling chinook, 3,044 hatchery steelhead and 560 wild steelhead. These fish were anesthetized, examined, allowed to recover from anesthesia and then placed in raceways for transportation. The tallies for examined fish were added to daily collection totals on the day after they were examined. Symptoms of GBT were observed on 100 fish including,76 with bubbles in the lateral line, one with bubbles in the caudal fin, nine with bubbles in the dorsal fin and eight with bubbles in eye tissues. We were able to net about 100 fish per day of both chinook and steelhead from April 7 to May 30. However, we sampled nearly twice as many steelhead as chinook because there were not enough chinook present at the separator in June to provide adequate sample sizes. We quit trying to collect chinook on June 1 and continued examinations with steelhead though June 30.

In addition to the fish netted and removed from the separator for GBT examinations, we netted and released 784 fish back into the separator because they were not the correct species, or were PIT-tagged. This total included 630 incidentally netted and untagged fish including, 29 hatchery yearling chinook, 8 wild yearling chinook, 292 hatchery steelhead, 138 wild steelhead, 139 coho, 31 hatchery sockeye and one wild sockeye. A total of 154 fish netted for the GBT study had PIT tags including, 129 hatchery yearling chinook, 10 wild yearling chinook, 10 hatchery steelhead, four wild steelhead and one coho.

Anesthetics

The use of MS-222® as an anesthetic to safely and efficiently sedate juvenile salmonids is an important component of the smolt monitoring programs. At LGR less than two percent, one-hundred-twenty-four thousand, of the nearly seven million total smolts collected in 1998 were anesthetized. The Fish Passage Center provides the Smolt Monitoring Program with sample rate guidelines that minimize daily sample sizes and allow large enough samples to provide unbiased estimates of species composition, condition and the recovery of unique marks to meet overall program goals. Reviews of techniques and methods employed at different sites by FPC, USGS-BRD and SMP program staff in 1992 provided more specific guidelines for standard stock solutions, minimal induction times and total exposure times for SMP sampling programs. At LGR concentrations between 60 and 70 mg/L of MS-222® from stock solutions of 100g/l typically enable us to follow the general guidelines and handle the juvenile salmonids safely and efficiently. Over the course of each season we make some adjustments to account for changes in water temperature, species composition, size and the number of fish in the sample. Induction and recovery times tend to decrease as water temperatures increase for a given concentration. Larger smolts typically respond more quickly to a given concentration than smaller smolts (steelhead versus chinook).

We accurately measure and add anesthetic to obtain the desired concentrations in the pre-anesthetic chambers and the re-circulating sample system (~672 liters). The pre-anesthetic chambers are drained to about 95 liters before we add about 60 ml of MS-222® to achieve an initial concentration of about 63 mg/l. This typically sedates nearly all the fish within three minutes. However the pre-anesthetic chambers are not watertight. Fresh water seepage reduces the effective concentration. Depending upon the amount of fresh water seepage, fish response, water temperature, the size and number of smolts in the chamber, we may add more MS-222®. Once sedated, these fish are flushed down to the sorting tank. The individual responsible for this task (pre-anesthetist) recorded the estimated number of smolts, the amount of MS-222® used (estimated concentration), the ratio of large to small smolts, and induction times for each batch.

The re-circulation system includes the sample trough, a return tank, an anesthetic reservoir, a rotary chiller, a filter and two pumps. Depending upon specific sampling needs for any given day up to three additional sampling/marking stations can be watered up as part of this system. Each station increases the system volume by 94 liters. The anesthetic is added to two small tanks in the pump room about 15 minutes prior to beginning the days sampling. The amount of MS-222® stock solution used was measured to achieve an initial concentration of about 60 mg/l. This level maintains sedation in most fish and allows some fish to gradually recover from the anesthetic and gives us sufficient time to carefully complete our sampling. The effective concentration of anesthetic in this system diminishes over time as more fish are sampled and absorb the anesthetic. Some leakage and infusion of fresh water also occurs throughout the sample. As a result careful monitoring of fish behavior and response is a constant component of our sample protocols and procedures. The longer we use the re-circulation system for a given days sample the more likely we are to add additional MS-222® in 50 to 100 ml increments to maintain effective concentrations. Again, we continuously watch and observe fish

behavior and gilling rates to ensure the safety of the fish and the efficiency of our sampling.

Occasionally we use the "canary test" to monitor changes in MS-222® concentrations. A smolt, selected at random, is placed at one end of the sorting tank and its behavior observed over the course of the daily sample. Healthy fish typically begin to recover and assume an upright position, tail slightly down and head up, within three to five minutes. Large fish, particularly steelhead, often become so active we have to remove them. Fish with visible injuries or with significant scale loss recover much more slowly and some would not recover at all. When these fish are removed and placed in buckets of fresh water with an air-stone (bubbler), the recovery times for healthy fish are comparable to those for fish removed from the sample tank.

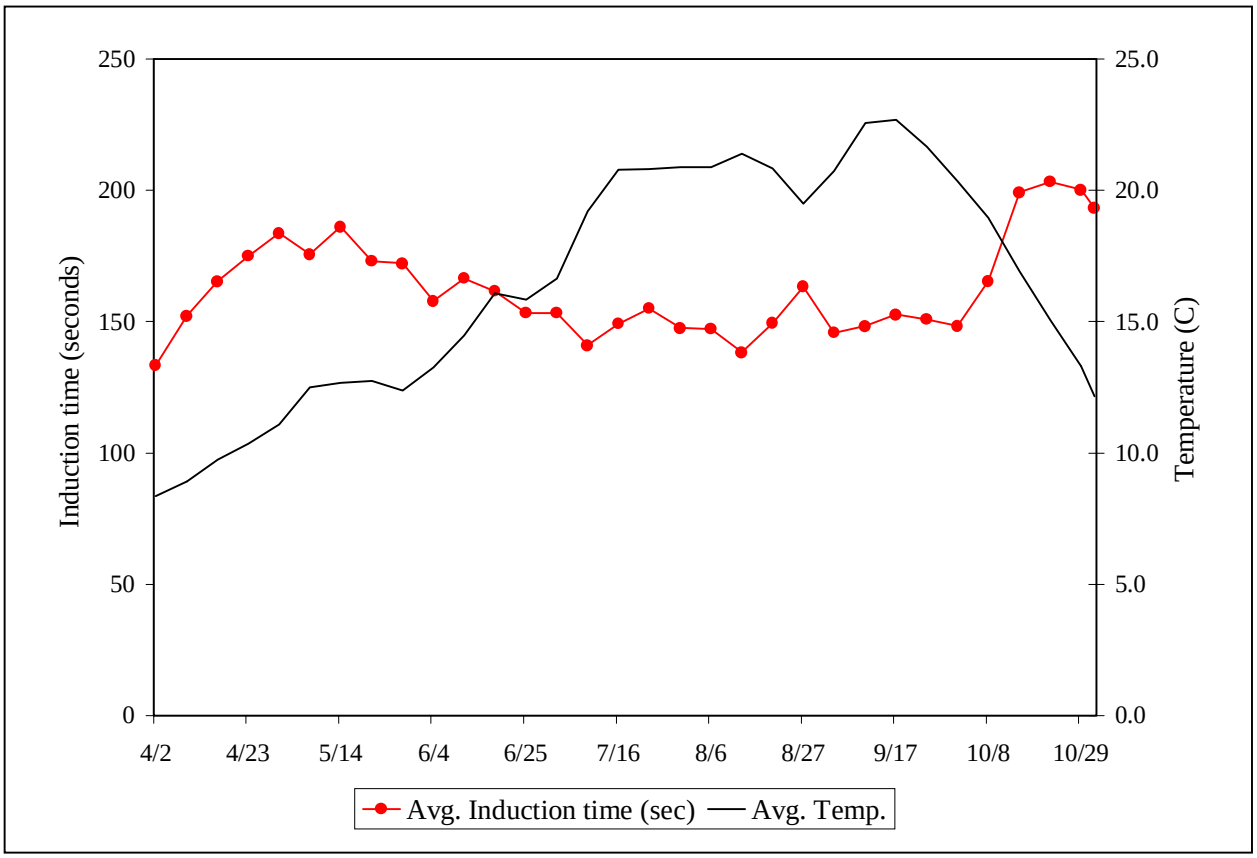
Anesthetic induction

Induction times to sedate fish sufficiently to minimize stress and allow staff to quickly and safely handle the fish should be greater than one but not longer than three minutes. For each batch of fish sedated this season, we recorded the estimated number of smolts, large and small (typically steelhead and chinook), water temperature, concentration of MS-222®, and induction times in the pre-anesthetic chamber. We did not see any trends in the weekly averages this season (Table 8). We recorded the time of induction as that point when about 95% of the fish were belly-up or on their side and gilling evenly. Steelhead dominated the batches throughout the spring migration until June 26. From July on age zero fall chinook were more abundant than steelhead. We observed that the larger fish, typically steelhead, responded more slowly to the anesthetic than did the smaller fish, typically chinook.

Table 8. Average induction times of sample fish exposed to concentrations of the anesthetic MS-222, by week at LGR, 1998

Week ending Date	Average Temp. (C)	Number of Batches	Average Fish/Batch	Average conc (mg/L) MS222	Average Induction (seconds)
4/2	8.3	20	32	61	133
4/9	8.9	99	54	60	152
4/16	9.8	81	52	61	165
4/23	10.3	94	44	78	175
4/30	11.1	171	61	60	184
5/7	12.5	178	65	60	176
5/14	12.7	107	46	60	186
5/21	12.7	75	30	60	173
5/28	12.4	113	46	60	172
6/4	13.3	94	50	60	158
6/11	14.5	93	30	61	166
6/18	16.1	108	43	60	162
6/25	15.8	91	30	60	153
7/2	16.6	119	33	59	153
7/9	19.2	101	45	49	141
7/16	20.8	58	46	50	149
7/23	20.8	72	42	50	155
7/30	20.9	58	34	55	148
8/6	20.9	37	30	59	147
8/13	21.4	41	27	60	138
8/20	20.8	36	29	77	149
8/27	19.5	38	29	62	163
9/3	20.7	36	34	60	146
9/10	22.6	31	37	60	148
9/17	22.7	37	34	60	153
9/24	21.7	56	34	60	151
10/1	20.3	55	39	60	148
10/8	19.0	50	37	60	165
10/15	16.9	37	33	60	199
10/22	15.1	27	32	60	203
10/29	13.3	16	28	60	200
11/1	12.2	12	28	60	193

Figure 7. Average induction times for batches of fish exposed to MS-222 (~60 mg/L) for daily samples each week at LGR, 1998.



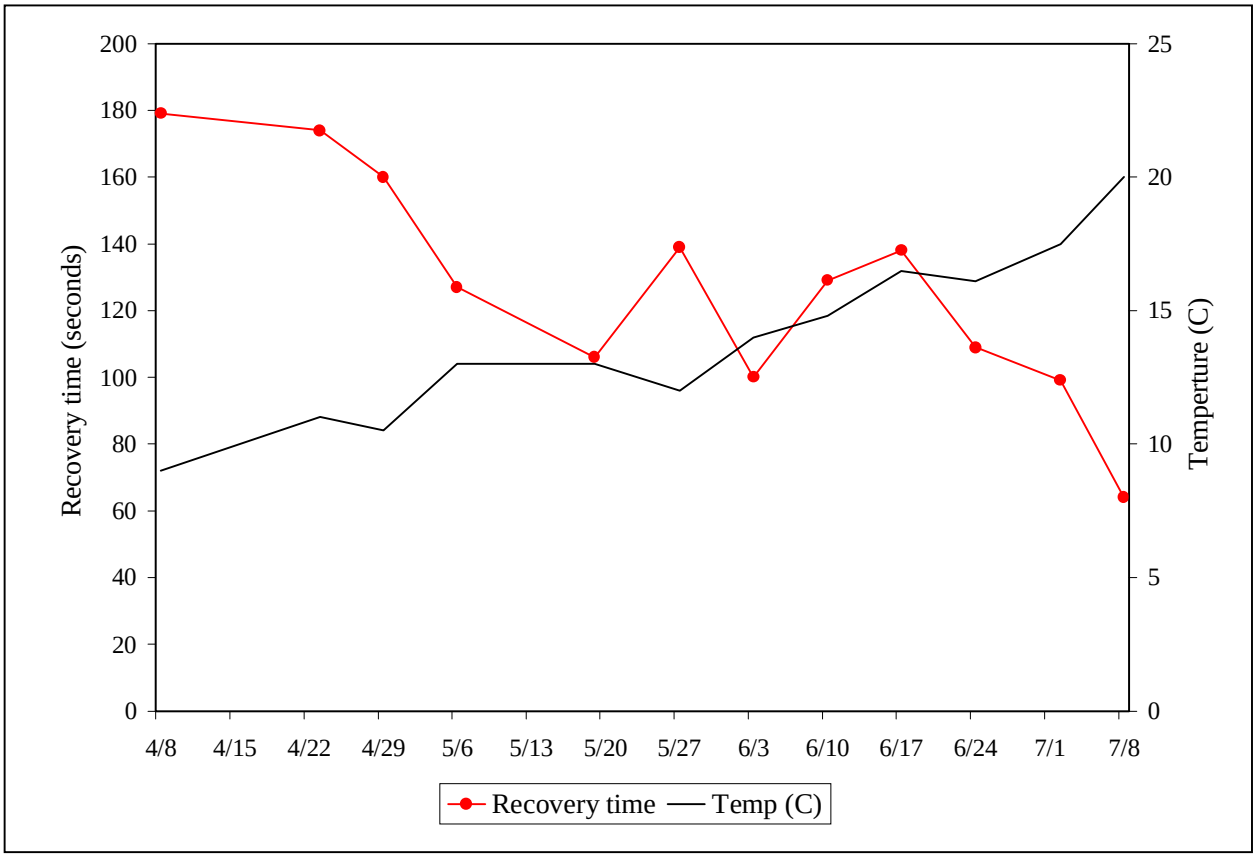
Anesthetic recovery

Over the past several seasons we have selected smolts from the sample and placed them in buckets with fresh water and an air stone to measure recovery times. Recovery times have been as short as a minute and a half and as long as five minutes. This season we conducted recovery tests once a week, from April 8 through July 8, on hatchery steelhead randomly chosen from batches throughout a sample (Table 9). A total of ten fish were tested each day, one fish per batch. Fish were selected immediately upon entering the sample tank, measured and placed into a bucket of freshwater containing an air stone. Timing of recovery began immediately. Timing stopped when the fish achieved and maintained an upright stable position. As water temperatures increased, induction and recovery times generally decreased (Figures 7 and 8) We recorded individual fork lengths to calculate averages for each week. It does not appear that fish size (fork length) influenced induction or recovery times.

Table 9. Average recovery time of hatchery steelhead exposed to MS-222® during daily samples at LGR between April 8 and July 8, 1998.

Sample Day	Temp (C)	Number of Fish timed	Average Fork Length	MS-222 @start (mg/L)	Induction Time (sec.)	Recovery Time (sec.)
4/8	9.0	10	213	60	174	179
4/23	11.0	10	220	60	181	174
4/29	10.5	10	235	60	180	160
5/6	13.0	10	209	60	194	127
5/19	13.0	10	239	60	170	106
5/27	12.0	10	235	60	173	139
6/3	14.0	10	236	60	171	100
6/10	14.8	10	228	60	161	129
6/17	16.5	10	246	60	153	138
6/24	16.1	10	211	60	153	109
7/2	17.5	10	239	50	156	99
7/8	20.0	10	255	50	132	64
Average	14.0	10	231	58	167	127

Figure 8. Average recovery times of hatchery steelhead exposed to MS-222 (~60 mg/L) at LGR, 1998.



Audit of data entry

During the course of the season, a total of 220 daily sample batches were generated and sent to FPC. A total of 141 batches, 64%, were resent because they were revised after they were originally sent. Most of the revisions occurred in the first 70 days of sampling when marked fish collection, research activities and GBT sampling was most prevalent. A total of ten batches were resent twice because the first revisions were not implemented. We categorized the errors that led to the revision into six categories; setup errors, recording errors, omitted data, fish identification errors, facility errors and miscellaneous changes (Table 10).

Table 10. Categories of errors that resulted in reposting of LGR sample batches, number of batches per category, percent of total reposted batches and percent of total batches for the season.

Category	Error Type	Number of reposted batches	Percent of total reposted batches	Percent of total number of batches
I	Setup	35	25%	16%
II	Recording	46	33%	21%
III	Omitted data	43	30%	20%
IV	Fish I.D.	3	2%	1%
V	Facility	11	8%	5%
VI	Miscellaneous	3	2%	1%
	Total	141		64%

Setup errors resulted from problems with templates or formulas within spreadsheets used to summarize daily data. The largest source of setup errors this season was caused by a faulty formula in the spreadsheet we used to calculate 24-hour average river flow data. The formula worked in 1997 when downloading files from the old COE bulletin board system (CROHMS). In 1998, the files became available on the internet and appeared identical to the 1997 files but in fact were not. The faulty formula omitted two hours of flow data and averaged 22 hours instead of 24. This setup error resulted in 32 daily data files resent to FPC. Five of these were resent twice because the first revision was not implemented. Another setup error occurred in one batch this season when a formula in the daily tally spreadsheet, which receives sample data and calculates collection counts, became invalid by a modification in that sheet. Finally, two batches were resent because one of the steps in the procedure to anchor the locations of input data in the digitizer data string was omitted.

Recording errors resulted from "typos" and inaccurate transcription of handlog data into the FPC16 data entry program. A total of 46 daily batches were revised and resent because of recording errors. These errors included incorrect entries of incidental codes (1), incorrect clip codes (3), incorrect rearing type entries (5), incorrect race codes (2), incorrect brand orientation codes (2), incorrect gear codes (1), incorrect application of sub-batch codes for research fish (12), incorrect categorization of recovery tank mortalities (3), numbers applied to incorrect data fields (5) and incorrect numbers (12) recorded in proper data fields. Most of the recording errors should have been detected prior to file transmission by comparing the handlogs to the FPC16

printouts. The revisions involving sub-batch codes and mortality categories however could not be detected through the printouts.

A total of 43 batches were revised with data that was initially omitted. Most of these revisions added GBT sample data and research data to incomplete batches in the data entry program. Batches revised with GBT data included seven that needed GBT sample totals and 25 that were updated with mark recapture information. Nine batches were revised to include some initially omitted research mortality and bypass data. Revisions of an additional nine batches were required to include sub-sample descaling counts (4), sub-sample mark recapture counts (2), transportation counts (2) and incidental counts (1).

Three batches were revised with changed fish identifications when we determined that fry originally reported as coho were actually wild subyearling chinook fry instead.

Facility errors resulted from events or changes in the data because of unusual operations, mistakes in fish facility data reporting, and technical problems related to the fish facility. Eleven batches were revised to correct errors in the reported data resulting from facility events. Of these, five batches were revised to account for an unusual combination of facility bypass records and research bypass reports that resulted in negative transportation totals. Two of the revised batches were updated to include facility mortality data not originally reported on daily mortality forms. One revision was to remove research sacrifice mortalities taken from a gate-well, outside of the fish facility, and originally attributed to the fish facility. Another batch was revised at the request of the COE to move some fish mortalities originally reported as facility mortalities to the transport mortality category. One batch required revision because incorrect flow data from the powerhouse's DAX computer was corrected. Finally, one batch was resent because the original transmission was incomplete, apparently because of a bad phone connection.

Miscellaneous errors resulted when the change in a posted batch was the result of a change in the previous batch. Three batches this season were revised because changes in fish numbers from the previous day changed the transportation totals.

There are several changes that can be made for next season to substantially reduce the number of errors that occurred this season. Many errors could have been avoided with more rigorous review and adherence to existing guidelines. Others require a reworking of methods.

The following is a list of improvements we will make to address each error category outlined above:

- Setup: setup, review and verify that all database tally spreadsheets are working correctly before the season begins. If in-season modifications are necessary, every formula should be re-verified. Also, procedures for setting up the digitizer should be reviewed.
- Recording errors: establish a field by field check-off procedure for comparing handlogs to printouts. Carefully review the FPC16 manual (and other FPC guidelines) for mark types and associated fin clips, race codes and brand orientations. Change the recovery tank mortality category to sample mortalities.
- Omitted data: review the FPC16 manual to establish exactly what is supposed to be

reported every day. Make a daily check off list. Make a new GBT daily summary form that is compatible with the FPC16 format. Refine the research forms to be more compatible with FPC16 format (especially the mortality category). Make a database out of FPC16 daily files that can be compared to our database.

- Fish I.D.: review fish identification at the beginning of the season.
- Facility errors: spend fifteen minutes to a half hour before the sample change every day reviewing the separator log and spreadsheet.

These modifications will help decrease the error rate of sample batches for next season. This list may be modified to better serve our goal of eliminating errors and is open to suggestions.

Fish Condition

Descaling

The combined 1998 descaling rate for all groups of 4.4% was second lowest in the last five years (Table 11). Annual descaling rates for hatchery and wild yearling chinook, wild subyearling chinook, steelhead, and hatchery and wild sockeye all decreased in 1998 compared to 1997. Hatchery coho and hatchery subyearling chinook descaling rates increased from 1997.

Average weekly descaling rates were highest during the spring migration, in late-May and early-June (Table 12). Average weekly descaling rates for hatchery yearling chinook never exceeded 9.4% when sample numbers exceeded 100 fish per week,. Wild subyearling chinook descaling rates exceeded 10% from 8 October through 1 November. Hatchery steelhead rates peaked at 9.2% for the week ending 4 June. Wild steelhead peaked at 8.4% in the week ending 18 June. Hatchery and wild sockeye sample numbers rarely exceeded 100 fish per week, and their descaling rates were low throughout the season.

Table 11. Annual descaling rates (%) for salmonid smolts sampled at Lower Granite Dam, 1994-1998.

	Yearling Chinook		Subyearling[1] Chinook		Steelhead		Sockeye/Kokanee[2]		Coho[3]	
Year	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Total
1994	3.7	3.6	---	2.1	5.4	2.0	---	12.5	---	4.3
1995	2.7	0.9	---	5.4	7.7	1.0	3.2	30.1	---	5.0
1996	3.0	1.5	---	9.3	6.3	1.1	3.8	18.4	2.4	5.8
1997	5.6	2.8	6.5	7.4	6.2	2.7	9.9	24.5	0.9	6.2
1998	3.1	2.3	9.9	4.7	5.3	2.2	4.7	3.0	4.3	4.4

[1]Hatchery subyearling chinook were not present until 1997.
[2]Hatchery sockeye/kokanee were not present until 1995.
[3]Hatchery coho were not present until 1995.

Table 12. Percent descaling by week for salmonid smolts sampled at Lower Granite Dam, 1998.

Week Ending	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Total
2-Apr	2.5	1.5	---	*0.0	2.0	1.1	---	*0.0	*0.0	1.5
9-Apr	1.1	0.9	---	*0.0	0.7	0.8	---	---	*0.0	0.8
16-Apr	0.9	0.6	---	*0.0	0.8	0.6	---	---	*0.0	0.8
23-Apr	1.6	1.1	---	---	3.3	1.6	---	---	*33.3	2.0
30-Apr	2.6	0.7	---	*0.0	3.0	1.6	---	---	*0.0	2.7
7-May	5.3	2.8	---	---	4.0	1.7	*0.0	---	2.4	4.0
14-May	4.8	4.6	---	*0.0	6.4	2.4	4.6	*0.0	1.9	5.6
21-May	6.4	*0.0	---	*0.0	6.4	2.1	*4.1	*0.0	6.0	5.9
28-May	7.8	1.6	---	*1.2	8.7	1.8	2.7	*0.0	5.7	7.1
4-Jun	*9.8	*5.8	*15.8	2.0	9.2	3.6	*2.7	*0.0	5.7	8.1
11-Jun	*0.0	*8.8	*13.3	2.3	8.2	6.0	*2.6	---	6.3	7.4
18-Jun	5.4	5.7	*7.7	2.1	4.6	8.4	1.7	---	9.6	5.0
25-Jun	9.4	7.7	*0.0	4.0	6.2	8.3	0.0	---	4.8	5.8
2-Jul	4.4	4.2	---	4.6	5.3	*1.2	*4.5	*0.0	*3.4	4.8
9-Jul	3.3	3.2	---	1.7	5.4	*4.5	*3.8	*50.0	2.9	2.8
16-Jul	*2.9	*16.7	---	1.3	5.6	*12.5	*0.0	*0.0	1.6	1.8
23-Jul	*1.4	*0.0	---	1.7	4.6	*0.0	*0.0	---	0.8	1.8
30-Jul	*5.3	*0.0	---	0.6	*14.4	*0.0	*0.0	---	*5.7	1.8
6-Aug	*0.0	*5.6	---	2.1	*12.3	*0.0	*0.0	---	*0.0	2.6
13-Aug	*2.2	*6.7	---	1.6	*16.7	*33.3	---	---	*0.0	1.8
20-Aug	*5.6	*5.6	---	1.8	*0.0	*0.0	---	---	*0.0	1.9
27-Aug	*3.9	*13.3	---	4.6	*0.0	*0.0	*0.0	*0.0	*0.0	4.6
3-Sep	*2.8	*11.8	---	3.1	*0.0	*0.0	---	*0.0	*0.0	3.2
10-Sep	*3.3	*0.0	---	7.6	*0.0	*0.0	---	*0.0	*7.7	7.1
17-Oct	*3.7	*9.1	---	5.1	*0.0	*0.0	*0.0	---	*6.2	5.1
24-Sep	*0.0	*0.0	---	4.5	*0.0	*0.0	---	*0.0	*0.0	4.3
1-Oct	*21.7	*50.0	---	8.9	*0.0	*16.7	---	---	*12.5	9.2
8-Oct	*10.3	*16.7	---	17.1	---	*0.0	---	*0.0	*6.7	16.7
15-Oct	8.3	*0.0	---	18.9	*0.0	*0.0	---	---	*0.0	13.5
22-Oct	4.4	8.3	---	20.6	0.0	0.0	0.0	0.0	0.0	11.0
29-Oct	2.3	25.0	---	10.9	0.0	0.0	0.0	0.0	11.1	6.2
1-Nov	1.8	14.3	---	10.2	0.0	0.0	0.0	0.0	0.0	4.1
#Descaled	551	159	7	1,098	3,208	197	194	29	1	5,444
#Exmined	17,931	7,003	71	23,210	60,290	8,834	4,110	955	23	122,427
%Descale	3.1	2.3	9.9	4.7	5.3	2.2	3.0	4.3	4.7	4.4

*Less than 100 fish sampled during the week.
---No fish sampled during the week

Injury and disease

In addition to standard descaling and weight data recorded for individual smolts in the daily sub-sample, We also examined these smolts for visible injuries and symptoms of disease. More than forty thousand smolts were examined in the detailed sub-sample this season, an increase of nearly 37% over 1997. This reflects the large number of subyearling chinook collected and diverted to the sample during the summer/fall migration period. The proportion of smolts with injuries and symptoms of disease (17.6%) is the highest we've recorded since we started collecting this data in 1996. In 1996 and 1997, 10.4% and 13.6%, respectively, of the smolts examined in the detailed sub-sample exhibited visible injuries and or signs of disease.

Head injuries that were noted during the season included abrasions and injuries to the eye, opercle, jaw and snout. Head injuries were recorded on 2.09% of smolts examined in 1998, more than double the 0.92 % observed in 1997. This years increase reflects the large number of subyearling chinook observed with injured snouts. Nearly 11.5% of wild subyearling chinook examined in the detailed sub-sample exhibited a loss of skin tissue over the insertion of the paired bones on the tip of the snout. Initially we assumed this injury resulted from physical contact with debris or structures within the collection system. However, we learned on September 20 (Warren Groberg, Fish Pathologist, ODFW, pers. comm.) that this is a common symptom associated with columnaris. We did not attempt to change the previous records for wild subyearling chinook. This symptom was most common during August and September when other symptoms of columnaris were most prevalent.

Body injuries that were noted this season included bloat, scars, emaciation, fin damage, lacerations and lack of mucus. About 2.7% of smolts examined this year exhibited some visible body injury, a nearly threefold increase over 1997. Fin injuries, split rays and fraying, were common in all species and ranged from 0.11% in hatchery sockeye/kokanee to 6.33% in wild subyearling chinook. The increase in the overall rate again reflects the greater abundance of wild sub-yearling chinook in the detailed sub-sample during the summer and fall migration period. The overall percentage of smolts recorded as emaciated increased from 0.02% in 1997 to 0.46% this year. Most of the emaciated smolts, predominately hatchery and wild yearling chinook, showed up in the sub-sample within a two-day period shortly after a large number of smolts were discovered trapped in fish screen slot 5B on June 12. A gap in the closure plate at the bottom of the fish screen slot allowed smolts to enter the fish screen slot, but not exit as the orifices to the collection gallery were closed. After this discovery the orifices were opened regularly to allow smolts to exit the fish screen slot into the collection gallery. The emaciated condition of these smolts, the high proportion of chinook, and advanced level of decomposition of

the morts collected during this time period suggest that many of these smolts were trapped in the fish screen slot for up to several weeks before this problem was detected.

Diseases with common external symptoms noted during the season include fungus, cysts, columnaris, digenia, gill hyperplasia, hemorrhaged fin, bacterial kidney disease, parasites and scoliosis. As in previous years fin hemorrhaging was the most common condition recorded for all species and was also more severe this year than in previous years. This condition, characterized by redness in the fin tissues caused by capillary dilation, is most common during the summer and fall when water temperatures are warmer, and is considered an indicator of stress. Fin hemorrhaging averaged 10.4% for all species this season and was highest for wild subyearling chinook (48.8%). Subyearling chinook, because they migrate in the summer and fall, generally exhibit more fin hemorrhaging than other species. Cooler water conditions in 1997 likely contributed to the lower incidence of hemorrhaging observed in all species (4.3%) and subyearling chinook (10.5%). In 1996, hemorrhaging was observed in 6.8% of all smolts examined and 20.9% of wild subyearling chinook.

The percentage of smolts observed with symptoms consistent with columnaris, yellowish blemishes, lesions, and loss of skin from the snout, increased this year. This disease, caused by the bacterium *Flavobacterium columnare*, infects mainly summer and early fall migrants because it becomes more virulent when water temperatures exceed 60 F. Columnaris rates in subyearling chinook increased from 0.34% in 1996 and 0.75% in 1997 to 7.8% in 1998. Subyearling chinook with open lesions characteristic of columnaris were observed in the detailed sub-sample on a daily basis starting August 13. Between two and ten percent of the sub-yearling chinook exhibited this symptom through September 22. Between October 2 and 8, when daily subyearling chinook counts averaged over 300 fish per day, columnaris was observed in 30% of the sub-yearling chinook examined. Columnaris symptoms peaked on October 4 when 44 of 96 (46%) subyearling chinook examined appeared infected. Although water temperatures started declining by mid September, the greater than expected numbers of subyearling fall chinook, extended holding (up to 48 hours) for the mini-tanker, and the presence of infected smolts with uninfected smolts may have contributed to the observed incidence and impact of columnaris in the sample. Warren Groberg, Fish Pathologist for Oregon Department of Fish and Wildlife visited the fish facility on September 30 and provided additional information on external symptoms characteristic of columnaris. Groberg explained that the snout injuries (loss of protective skin tissue) and yellowish blemishes without broken skin were also symptoms of *F. columnare* infection. Relative levels of *F. columnare* cultured from snouts of eight smolts on September 30 indicated that all of these fish had some level of infection and five had "very heavy" infections. Based on this information, most of the subyearling chinook with this symptom, that were

characterized as a physical injury from July 22 to September 30 were most likely infected with columnaris.

Gill hyperplasia in hatchery steelhead, characterized by swollen or "club-shaped" gill filaments, decreased to 1.3% in 1998. In 1996, approximately 13.5% of hatchery steelhead examined were infected. In 1997, 5.9% of hatchery steelhead were infected. This condition is primarily associated with hatchery steelhead and occurs throughout the main portion of the migration in April and May.

Injuries associated with predator marks included wounds inflicted by anglers, birds, and lampreys. This year, as in 1996 and 1997,birds were the primary predator causing most of the injuries. Bird predation marks, characterized by V-shaped scratches on both sides of a fish, were most prevalent on hatchery steelhead (1.8%) and wild steelhead (1.7%). In 1996, 2.5% of hatchery steelhead and 0.8% of wild steelhead sub-sampled had bird predator marks. In 1997, 2.0% of hatchery and 1.4% of wild steelhead had bird predator marks. Wounds inflicted by anglers, characterized by torn or punctured tissues in the jaw area, although very low, were highest on hatchery steelhead, (0.05%). Very few lamprey marks, characterized by the presence of small disc-shaped patches of scale loss sometimes with central petechial hemorrhaging, were noted this season. Though juvenile lamprey counts in the sample tank were relatively high during the fist two weeks of the season, very few smolts examined during this period showed any evidence of having been attacked by the juvenile lamprey. Lamprey marks were observed only on hatchery yearling chinook (0.02%) and wild steelhead (0.02%). Lamprey marks on sample fish in 1996 and 1997 were also rare, occurring in 0.01% and 0.03% of fish examined.

Incidental Fishes

Incidental fishes

In addition to recording the number of salmonid smolts, we also recorded the numbers of other species of fish that were sampled or collected at the juvenile fish facility (Table 13 and 14). The incidental fish counts tallied during daily samples were expanded according to the daily sample rates. Fish that were small enough to pass through the separator bars and end up in the sample tank or the raceways included a mixture of adult and juvenile fishes. Fish collected at the separator were predominantly adult fish too large to pass through the separator bars and were released directly to the river by COE technicians. We recorded age-class information for adult salmonids in the sample. All salmonids and non-salmonid fishes reported released from the separator were assumed to be adult fish. Non-salmonid and adult fishes from the sample were bypassed to the river. The remainder of the incidental fishes were collected into the raceways and were transported.

Fishes removed from the separator and bypassed this year totaled 14,748 fish and included 7,976 non-salmonids (Table 13) and 6,772 salmonids (Table 14). Adult salmonid counts and condition information collected by the COE at the separator are presented in the Adult Fallback section of this report. The majority of the non-salmonid fishes from the separator were carp (3,739) and suckers (3,846).

There were a total of 78 adult salmonids recorded in the daily samples this season including 43 chinook and 35 steelhead. These steelhead were generally emaciated and narrow enough to fit through the separator bars. Adult steelhead in the sample included 19 hatchery fish (two kelts) and 16 wild fish (one kelt). The chinook included 32 hatchery jacks (12 to 22 inches), 8 mini-jacks (6 to 12 inches) and one wild jack and two wild mini-jacks. Of the hatchery jacks, 24 (75%), were marked with color coded elastomer tags. The elastomer marked jacks included 17 left-orange, four right-green, one left-green and one left-blue. There were two adult fish in the sample recorded as mortalities during the season, one wild chinook mini-jack and one hatchery chinook jack. Eight adult fish in the sample were marked with double operculum punch holes. These fish were all hatchery chinook jacks that were marked by NMFS staff at the adult fish trap when the fish were handled while ascending the ladder at LGR.

In the sample, a total of 31,853 non-salmonid fish were identified during the season. These represented a total collection of over 113,000 fish. Most incidental non-salmonid fishes in the sample were bypassed directly from the sorting tank to the river. Incidental salmonids in the sample were placed in fresh water for at least five minutes and then released off the end of the barge dock. The five most abundant non-salmonid fishes in daily samples were: black crappie (13,879), suckers (7,138), Peamouth (3,326), mountain whitefish (2,280) and channel catfish (1,317). However, the order of abundance changed when we estimated total collection based on the daily sample rates. Here, the five most abundant fishes in the collection include: pacific lamprey (32,273 all age classes), suckers (31,447), black crappie (14,527), peamouth (12,794) and mountain white fish (9,507). Based on the sample estimates, about 81,000 non-salmonid fishes were transported from LGR after collection into the raceways or barges. Most of these

were lamprey (30,587) and suckers (24,309). In addition to the fish that were collected into raceways and barges, all juvenile and ammocete pacific lamprey from the sample (30,587) were transported.

Based on sample counts and sample rates, a total of 923 adult salmonids were estimated, to have been transported. Most of the chinook jacks in the sample were small enough to fit through the separator bars and we feel their estimated number in the total collection was well represented by the samples. Also, adult chinook generally pass LGR in the fall when the sample gate is open all of the time. Based on the 43 chinook jacks in the sample, and daily sample rates, estimated 15 jacks were transported. Adult steelhead however could not pass easily through the bars of the separator because their heads are generally too large. Based on 35 adult steelhead counted in daily samples and sample rates, we estimate 908 adult steelhead were collected into raceways and barges and transported. Adult steelhead collection estimates may be biased by the difference between head size and the gap in the separator bars.

Table 13. Collection of incidental fish at Lower Granite Dam, 1998.

Common Name	Scientific Name	Separator	Sampled	Transported	Total
Bass, Largemouth	*Micropterus salmoides*	0	0	0	0
Bass, Smallmouth	*M. dolomieui*	2	107	378	487
Bluegill	*Lepomis machrochirus*	0	113	68	181
Bullhead (misc.)	*Amierus sp.*	1	112	15	128
Carp	*Cyprinus carpio*	3,739	112	116	3,967
Channel Catfish	*Ictalurus punctatus*	167	1,317	1,481	2,965
Chiselmouth	*Acrocheilus alutaceus*	0	1,075	4,565	5,640
Crappie, Black	*Pomoxis sp.*	89	274	783	1,146
Crappie, White	*Pomoxis sp.*	0	13,879	648	14,527
Crayfish	*Cambarus sp.*	0	6	10	16
Dace, Longnose	*Rhinichthys cataractae*	0	1	9	10
Kokanee[2]	*Oncorhynchus nerka*	0	0	0	0
Lamprey, Pacific (Adult)	*Entosphenus tridentatus*	3	14	12	29
Lamprey, Pacific (Juv.eyed)	*E. tridentatus*	0	1,174	23,761	24,935
Lamprey, Pac. (Ammocete)	*E. tridentatus*	0	498	6,814	7,312
Northern Pikeminnow	*Ptychocheilus oregonensis*	9	140	260	409
Peamouth	*Mylocheilus caurinus*	2	3,326	9,468	12,796
Pumpkinseed	*Lepomis gibbosus*	0	62	79	141
Rainbow Trout	*Oncorhynchus mykiss*	0	92	925	1,017
Sculpin	*Cottus sp.*	0	68	195	263
Shad (Adult)	*Alosa sapidissima*	34	5	12	51
Shad (Juvenile)	*A. sapidissima*	0	53	0	53
Shiner, Redside	*Richardsonius balteatus*	0	1	9	10
Smelt, Longfin	*Osmeridae sp.*	0	1	3	4
Sturgeon, White	*Acipenser transmontanus*	83	8	0	91
Sucker (misc.)	*Catostomus sp.*	3,846	7,138	24,309	35,293
Tadpole Madtom	*Noturus gyrinus*	0	0	0	0
Three-spine stickleback	*Gasterosteus aculeatus*	0	0	0	0
Walleye	*Stizostedion vitreum*	0	0	0	0
Whitefish, Mountain	*Prosopium sp.*	1	2,280	7,227	9,508
Yellow Perch	*Perca flavescens*	0	3	152	155
Total		7,976	31,859	81,299	121,134

[1]Incidental species collection estimated based on numbers sampled, sample rates, and separator counts.
[2]Kokanee in the sample are classified as any sockeye juvenile over 200 mm in length.
[3]Rainbow trout were distinguished from steelhead by morphology and smoltification.

Table 14. Adult salmonids counted at the separator and in the sample at LGR, 1998.

Common Name	Scientific Name	Separator	Sampled	Transported	Total
H.CH adult	*Onchorhynchus tshawytscha*	121	0	0	121
H.CH jack	*O. tshawytscha*	131	32	0	163
H.CH minijack	*O. tshawytscha*	0	8	6	14
W.CH adult	*O. tshawytscha*	105	0	0	105
W.CH jack	*O. tshawytscha*	32	1	9	42
W.CH minijack	*O. tshawytscha*	0	2	0	2
H.ST adult	*O. mykiss*	4,340	17	530	4,887
H.St kelt	*O. mykiss*	0	2	9	11
W.ST adult	*O. mykiss*	2,043	15	359	2,417
W.St kelt	*O. mykiss*	0	1	10	11
H.SO adult	*O. nerka*	0	0	0	0
W.SO adult	*O. nerka*	0	0	0	0
U.CO adult	*O.kisutch*	0	0	0	0
		6,772	78	923	7,773

Adult Fallbacks

A total of 6,772 adult salmonids were removed from the Lower Granite separator in 1998 (Table 15). This included: 226 adult chinook, 163 jack chinook, 4,340 hatchery steelhead, and 2,043 wild steelhead. Hatchery steelhead were the most abundant adult salmonid removed from the separator and made up 64% of the total fallbacks during 1998. Wild steelhead were the second most abundant and made up 30% of the fallbacks. As is typical at Lower Granite Dam, April and May were the months of highest fallback for hatchery and wild steelhead while chinook fallback counts were highest in October (Table 16).

The numbers of adult chinook removed from the separator were lower but jack chinook were higher than in the two previous years. Wild steelhead and jack chinook fallbacks were higher than each of the previous four years. Numbers of adult hatchery steelhead were about the same as the four-year average. All fallbacks were superficially examined for condition while being released off the separator. The vast majority of the fish were in good or fair condition (Table 17).

Table 15. Annual totals of adult salmonids released from the juvenile fish separator at Lower Granite Dam, 1994-1998.

Year	Adult Chinook	Jack Chinook	Hatchery Steelhead	Wild Steelhead	Total
1994	8	10	2,063	1,476	3,567
1995	60	49	3,660	2,127	5,896
1996	150	70	5,385	1,167	6,772
1997	470	19	6,609	1,944	9,042
1998	226	163	4,340	2,043	6,772

Table 16. Monthly totals of adult salmonids released from the juvenile fish separator at Lower Granite Dam, 1998.

Month	Adult Chinook	Jack Chinook	Hatchery Steelhead	Wild Steelhead	Total
April[1]	3	0	1,571	626	2,200
May	46	12	1,666	1,016	2,740
June	26	6	92	226	350
July	46	4	62	20	132
August	6	2	50	23	81
September	16	6	170	44	236
October[2]	83	133	729	88	1,033
Total	226	163	4,340	2,043	6,772

[1] Includes March 27-31.
[2] Includes November 1.

Table 17. Condition of adult salmonids released from the juvenile fish separator at Lower Granite Dam, 1998.

Condition	Adult Chinook	Jack Chinook	Hatchery Steelhead	Wild Steelhead	Total
Good	170	154	3,435	1,786	5,545
Fair	40	9	679	197	925
Poor	10	0	167	54	231
Dead	6	0	59	6	71
Total	226	163	4,340	2,043	6,772

Fish Collection

Migration and Collection

Total collection estimates were derived from expanded hand counts of smolts in the daily sample and includes fish removed from the separator (Table 18). PIT-tagged fish present when the sample slidegate was open entered the daily sample holding tank along with run-at-large sample fish until June 10. The PIT-tag bypass system was then set to over-ride the sample slide-gate and divert PIT-tagged fish intead to the sample tank. In this event it is possible that one or more untagged fish, present when the sample gate was open, could be diverted as well. With the exception of the "diversion-by-code" system, all PIT-tagged fish detected exiting the separator were diverted back to the river. This could result in some underestimation of daily and thus total collection. This bias should have little, if any, impact on spring chinook, steelhead, coho, and sockeye collection estimates but may impact collection estimates for fall sub-yearling chinook whose primary migration occurs after June 10.

The juvenile fish bypass gallery was watered up on March 16. Fish were bypassed through the 42-inch pipe (primary bypass) until 0730 on March 26, when the separator was watered up and collection of fish for transportation began. Collection ended at 0700, November 1. An estimated 6,977,214 juvenile salmonids were collected at Lower Granite Dam during the 1998 season. The species composition included: 1,317,503 hatchery yearling chinook, 287,186 wild yearling chinook, 520 hatchery subyearling chinook, 81,286 wild subyearling chinook, 4,527,534 hatchery steelhead, 557,991 wild steelhead, 48,623 hatchery sockeye/kokanee, 1,025 wild sockeye/kokanee and 155,546 hatchery coho (Appendix 1, Table 1).

Fish collection and transportation numbers were about equal to the five-year average for most species (Table 18). Hatchery and wild yearling chinook total collection estimates increased significantly over the previous two years. Wild subyearling chinook counts exceeded counts in any of the previous four years by more than 60%.

Hatchery subyearling chinook were released above LGR in 1998 and all were PIT-tagged and not marked with fin clips or other external marks. These fish were supposed to be bypassed automatically to the river via the PIT-tag diversion system. Some chinook in this year's sample, however, were also identified as hatchery subyearling chinook based on body morphology and an adipose fin clip. This was a surprise as there were no official releases of fin clipped subyearling chinook. At total of 73 hatchery subyearling chinook were counted in daily samples between May 29 and June 25. Average fork lengths for these fish were in the 98 to 138 mm range. Given the sample rates at these times, an estimated 520 hatchery subyearling chinook were collected. Approximately 155,546 coho smolts were also collected at Lower Granite during 1998. The Nez Perce Tribe released over 500,000 coho above LGR prior to the 1998 season.

Table 18. Annual collection, bypass, and transport at Lower Granite Dam, 1994-1998.

Year	Yearling Chinook Hatchery	Yearling Chinook Wild	Subyearling[1] Chinook Hatchery	Subyearling[1] Chinook Wild	Steelhead Hatchery	Steelhead Wild	Sockeye/Kokanee[2] Hatchery	Sockeye/Kokanee[2] Wild	Coho[3] Hatchery	Total
Collection										
1994	1,862,390	316,939	---	6,769	4,223,477	477,925	---	23,201	---	6,910,701
1995	2,991,449	789,070	---	31,019	5,501,552	414,082	2,552	3,773	---	9,733,497
1996	462,995	126,895	---	17,346	4,264,688	321,821	5,137	9,762	19,028	5,227,672
1997	224,847	56,978	73,437	17,473	4,022,510	300,215	411	2,937	1,517	4,700,325
1998	1,317,503	287,186	520	81,286	4,527,534	557,991	48,623	1,025	155,546	6,977,214
Bypass										
1994	14,618	555	---	3	39,487	2,384	---	105	---	57,152
1995	222,928	53,260	---	1,590	368,705	22,014	1	104	---	668,602
1996	49,978	19,332	---	358	30,883	977	0	0	765	102,430
1997	407	787	1,031	617	110,753	2,941	0	0	29	248,078
1998	88,312	20,074	0	1,003	107,561	17,990	0	0	1,474	236,414
Truck										
1994	8,791	26,858	---	6,628	93,048	13,570	---	1,884	---	150,779
1995	37,526	89,658	---	28,068	71,430	13,389	2,310	784	---	243,165
1996	2,207	4,004	---	15,857	82,108	12,802	889	6,054	2,966	126,887
1997	2,659	3,100	70,793	15,221	134,154	20,533	399	799	420	248,078
1998	21,764	20,344	18	70,260	49,629	18,215	613	32	6,430	187,305
Barge										
1994	1,831,163	288,328	---	97	4,085,149	461,715	---	20,524	---	6,686,976
1995	2,722,029	644,226	---	787	5,059,422	378,619	229	2,822	---	8,808,134
1996	407,960	102,368	---	885	4,149,222	307,805	4,120	3,184	15,254	4,990,798
1997	219,683	52,679	0	998	3,774,369	276,520	0	2,022	1,066	4,327,337
1998	1,203,805	245,809	489	8,043	4,366,903	521,297	47,921	990	147,145	6,542,402
Total Transported										
1994	1,839,954	315,186	---	6,725	4,178,197	475,285	---	22,408	---	6,837,755
1995	2,759,555	733,884	---	28,855	5,130,852	392,008	2,539	3,606	---	9,051,299
1996	410,167	106,372	---	16,742	4,231,330	320,607	5,009	9,238	18,220	5,117,685
1997	222,342	55,779	70,793	16,219	3,908,523	297,053	399	2,821	1,486	4,575,415
1998	1,225,569	266,153	507	78,303	4,416,532	539,512	48,534	1,022	153,575	6,729,707

[1]Hatchery subyearling chinook were not present until 1997
[2]Hatchery sockeye were not present until 1995.
[3]Hatchery coho were not present until 1996.

Migration timing

Peak collection days in 1998 followed the general pattern observed in the previous five years, except for 1997 (Table 19). The peak daily collection total on May 4 was also the peak collection day for hatchery yearling chinook and hatchery steelhead. Hatchery coho and hatchery and wild sockeye/kokanee peaked on May 15. There were 21 days in which total collection exceeded 100,000 fish and two days with over 200,000 fish. A few wild subyearling chinook were seen in the sample in April and May, but did not appear on a regular basis until the middle of June. Collection peaked in mid-July, declined slowly through August, and increased through late September (Figures 18 and 19). Wild steelhead peaked earlier than their hatchery counterparts.

Table 19. Annual peak collection days at Lower Granite Dam, 1994-1998.

	Yearling Chinook		Subyearling[1] Chinook		Steelhead		Sockeye/Kokanee[2]		Coho[3]	
Year	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Total
1994	May 10	April 24		July 9	May 10	April 24	---	May 12	---	May 10
	(137,577)	(27,097)	---	(470)	(353,101)	(39,698)	---	(2,411)	---	(514,500)
1995	May 2	May 3	---	July 28	May 3	May 10	July 6	May 1,10	---	May 3
	(288,000)	(30,600)	---	(1,170)	(654,000)	(34,050)	(400)	(300)	---	(910,051)
1996	May 14	April 21	---	July 13	April 27	April 27	May 17	April 2	May 19	April 27
	(31,350)	(9,000)	---	(1,004)	(366,900)	(22,350)	(750)	(910)	(1,650)	(407,550)
1997	April 22	April 22	July 18	July 2	May 2	April 22	July 25	April 22	May 27	May 2
	(13,070)	(5,730)	(2,876)	(480)	(250,146)	(27,821)	(28)	(400)	(150)	(261,350)
1998	May 4	May 3	June 1	July 9	May 4	April 28	May 15	May 15	May 15	May 4
	(70,950)	(19,050)	(60)	(6,210)	(375,900)	(40,220)	(5,550)	(450)	(15,000)	(489,450)

[1]Hatchery subyearling chinook were not present until 1997.
[2]Hatchery sockeye were not present until 1995.
[3]Hatchery coho were not present until 1996.

The distribution of daily collection counts for a particular species provides a measure of migration timing for smolts passing Lower Granite Dam (Table 20 and Figure 9). These dates of 10% and 90% passage are based on the cumulative daily collection. Collection efficiency, spill and spill volume influence daily and seasonal collection at the facility. Thus the 10 and 90% dates are approximations of the middle 80% passage timing for smolts passing LGR. The 1998 dates of estimated 10% and 90% passage are shown with the corresponding 10 and 90% passage dates of the previous four years.

Table 20. Passage dates for 10% and 90% (middle 80 percent) passage of smolts by species at LGR, 1994-1998.

	Chinook						Steelhead				Coho		Sockeye/kokanee			
	h.ch1		w.ch1		w.ch0		h.st		w.st		co		h.so		w.so	
	10%	90%	10%	90%	10%	90%	10%	90%	10%	90%	10%	90%	10%	90%	10%	90%
1998	4/20	5/9	4/11	5/17	6/23	8/29	4/26	6/12	4/24	5/22	5/5	5/28	5/7	5/25	5/10	5/25
1997	4/20	5/18	4/11	5/14	6/18	8/21	4/20	5/21	4/16	5/17	5/20	6/25	7/16	9/24	4/22	7/4
1996	4/23	5/19	4/17	5/19	6/27	8/29	4/25	5/18	4/17	5/20	5/18	6/17	5/17	6/14	4/22	7/4
1995	4/22	5/15	4/15	6/3	7/7	9/21	4/28	5/21	4/24	5/23			6/17	7/13	5/1	7/21
1994	4/25	5/12	4/22	5/18	7/3	8/22	4/27	5/17	4/23	5/15			5/7	6/6		

The middle 80% passage period for wild yearling chinook, subyearling chinook and wild steelhead in 1998 was comparable to the previous four years. The middle 80% passage period for hatchery yearling chinook began near the same dates as in previous years but ended nearly 10 days earlier. For hatchery steelhead in 1998, the middle 80% period was approximately two weeks longer than previous years. Coho passage in 1998 was about two weeks earlier and occurred over a shorter period than in 1997 and 1996. The middle 80% passage periods for sockeye/kokanee this season were much shorter than previous years. Hatchery sockeye/kokanee passage dates were earlier than in previous years while wild sockeye/kokanee passage dates were later.

Figure 9. Middle 80% run-timing at Lower Granite Dam, 1998.

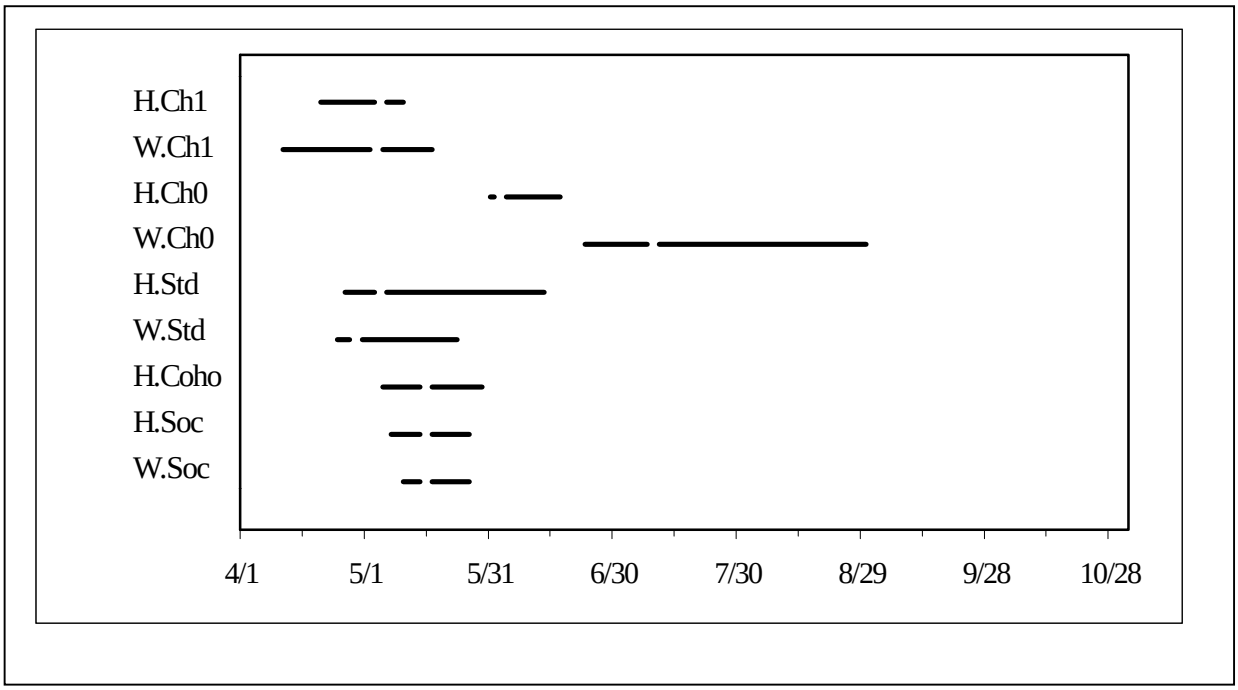


Figure 10. Daily juvenile salmonid collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

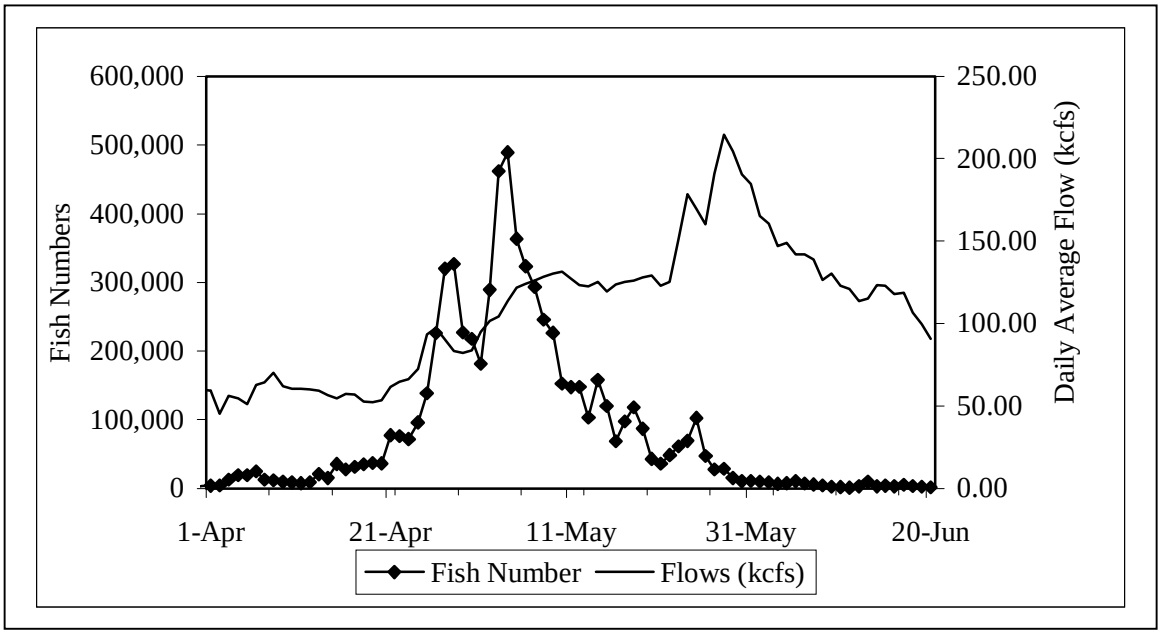


Figure 11. Daily juvenile salmonid collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.

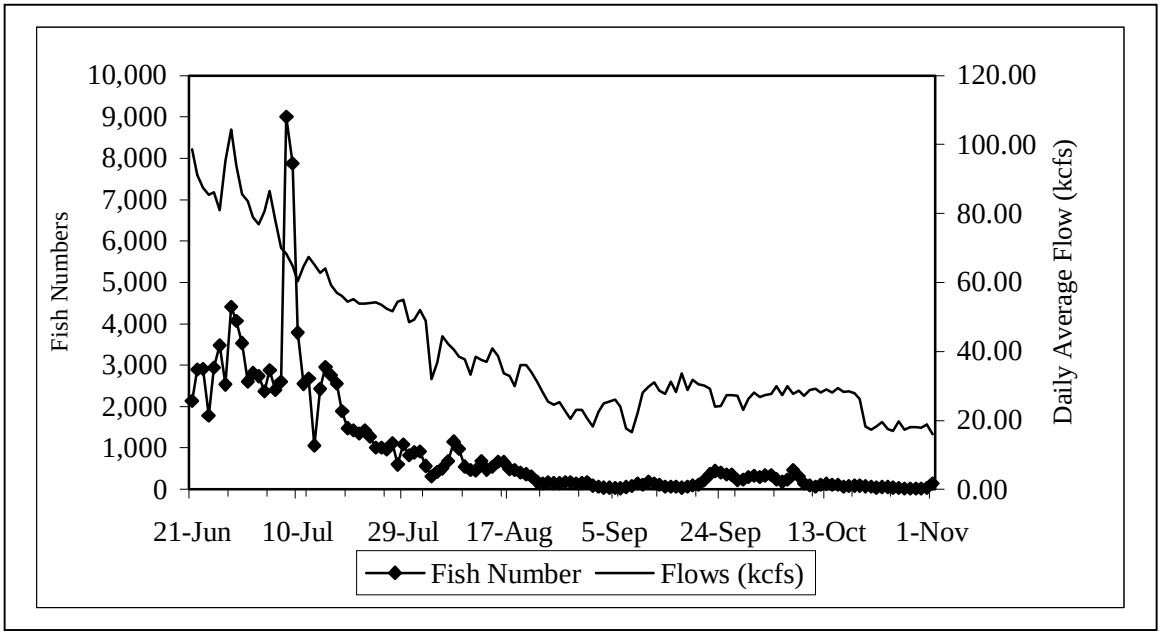


Figure 12. Daily hatchery yearling chinook collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

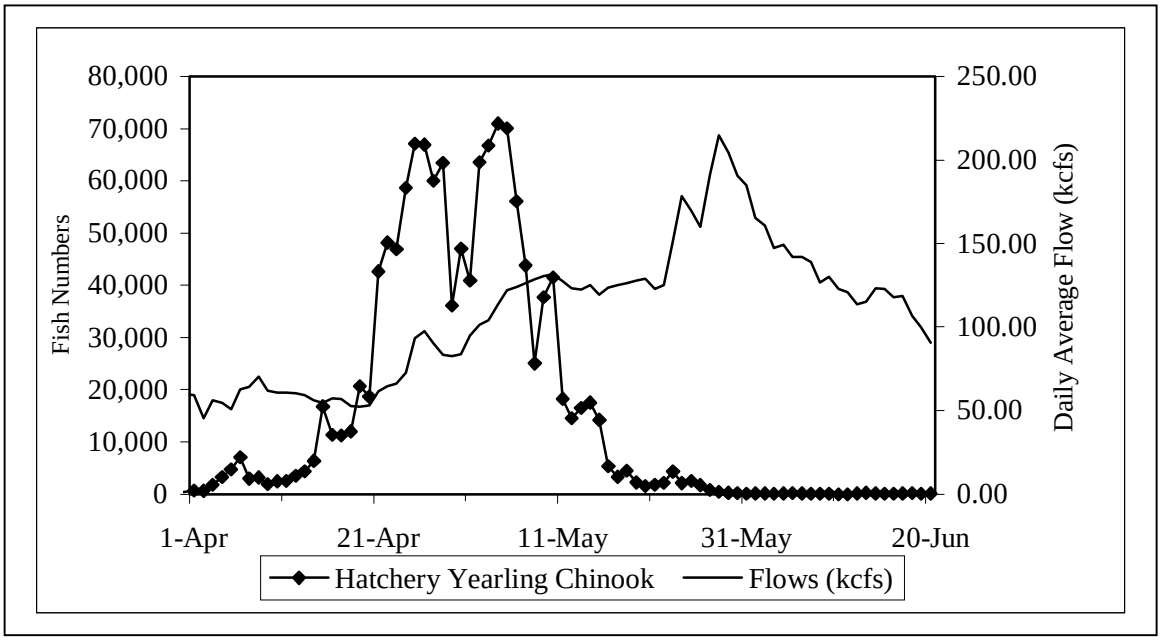


Figure 13. Daily hatchery yearling chinook collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.

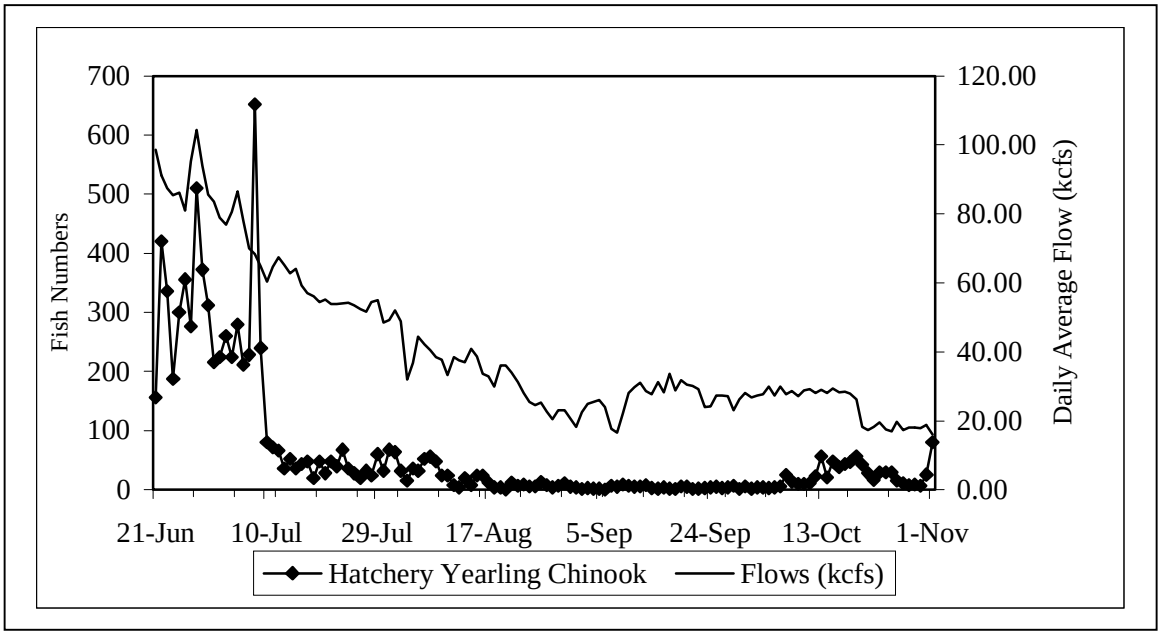


Figure 14. Daily wild yearling chinook collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

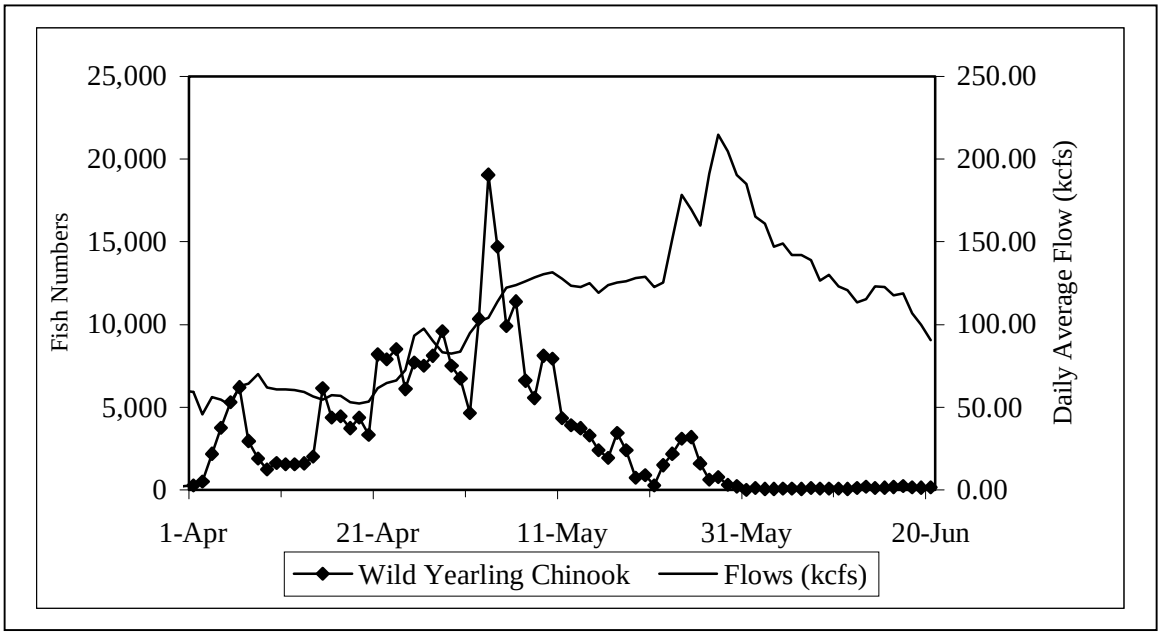


Figure 15. Daily wild yearling chinook collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.

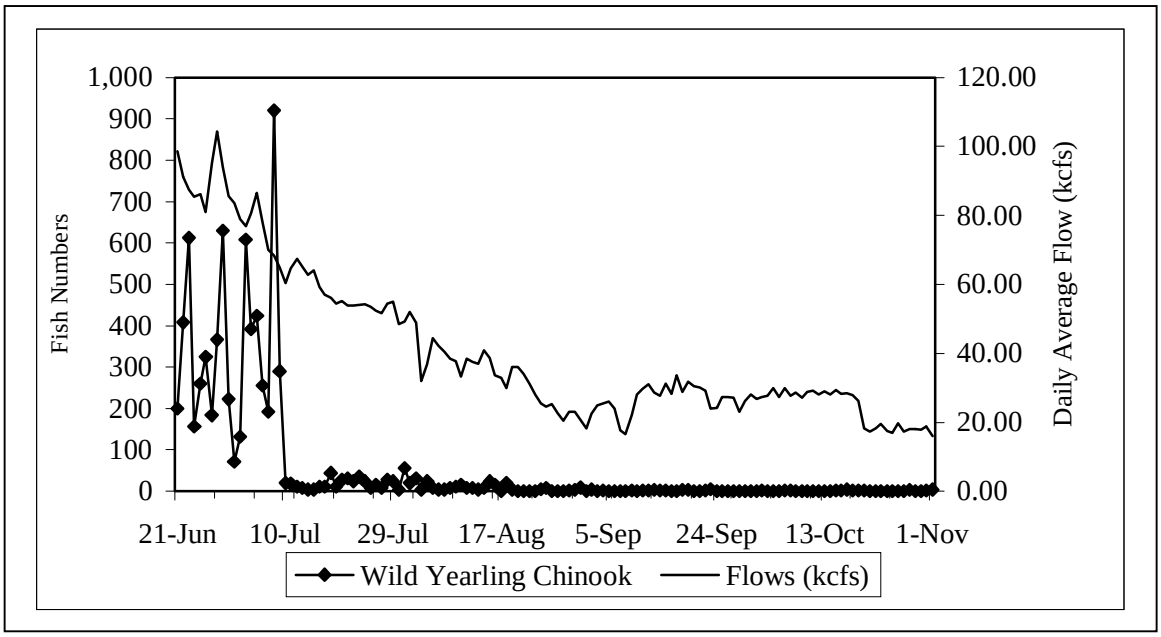


Figure 16. Daily hatchery subyearling chinook collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

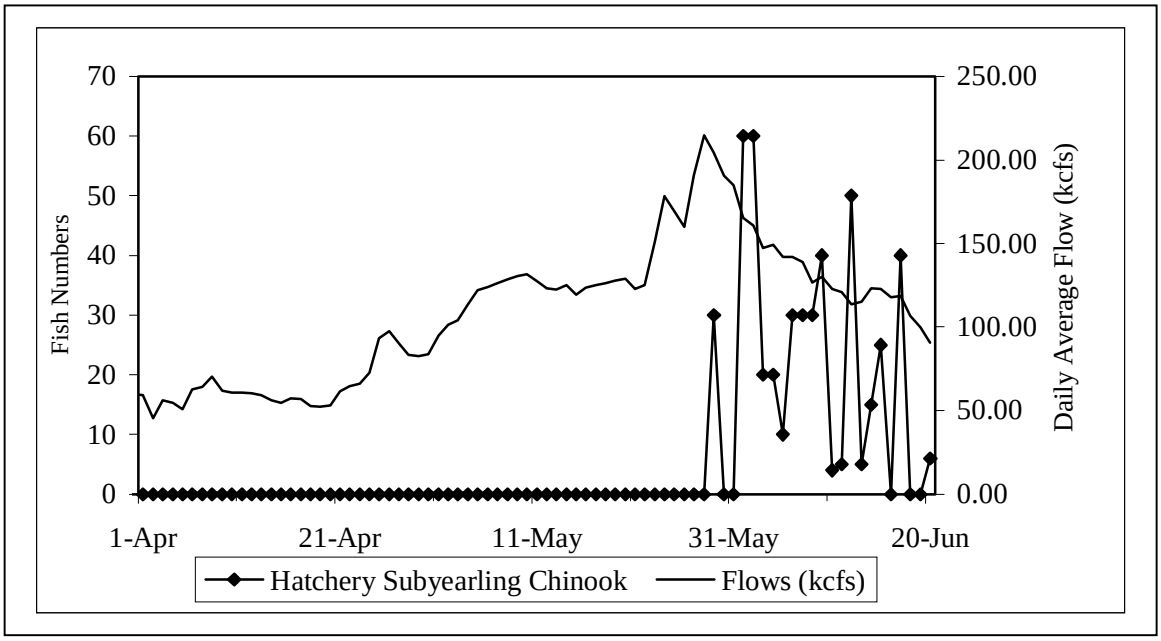


Figure 17. Daily hatchery subyearling chinook collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.

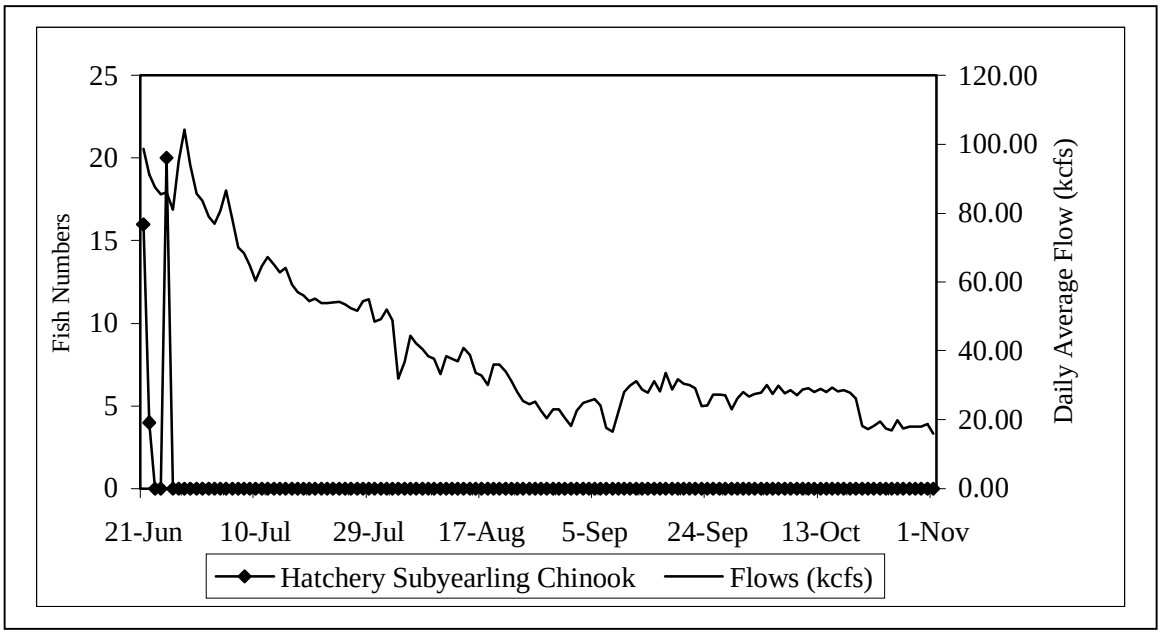


Figure 18. Daily wild subyearling chinook collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

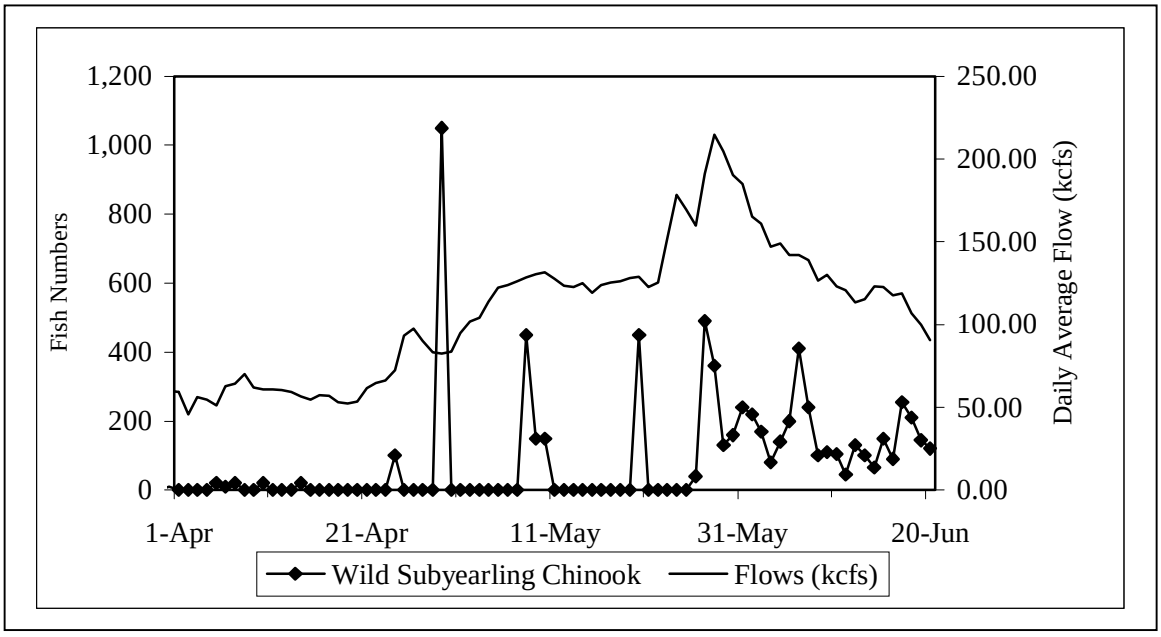


Figure 19. Daily wild subyearling chinook collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.

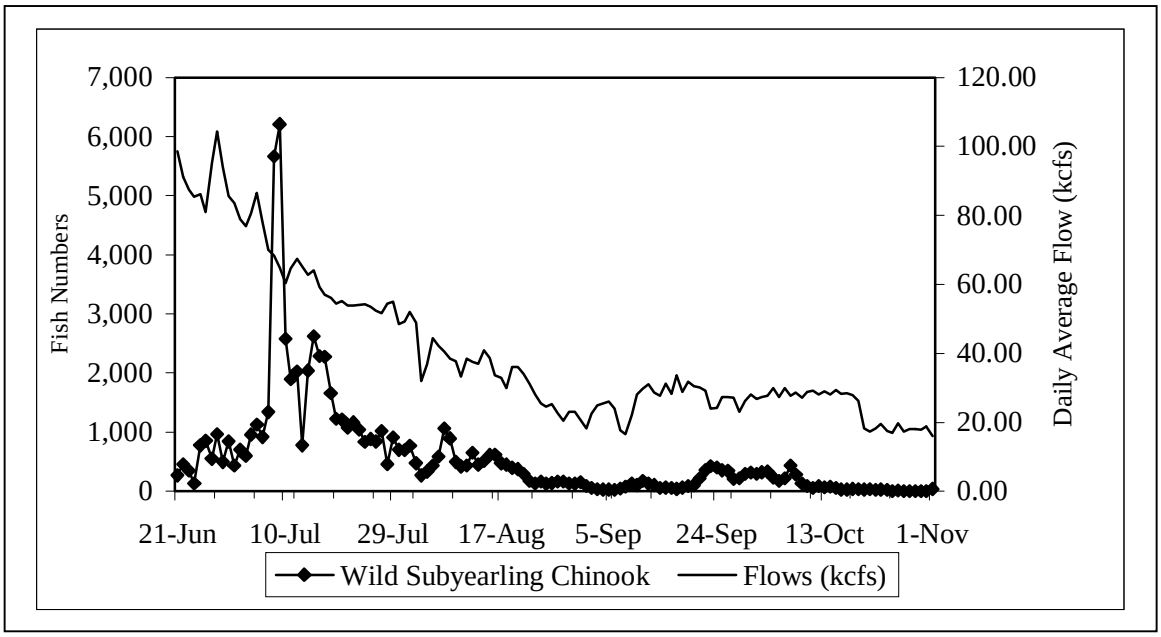


Figure 20. Daily hatchery steelhead collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

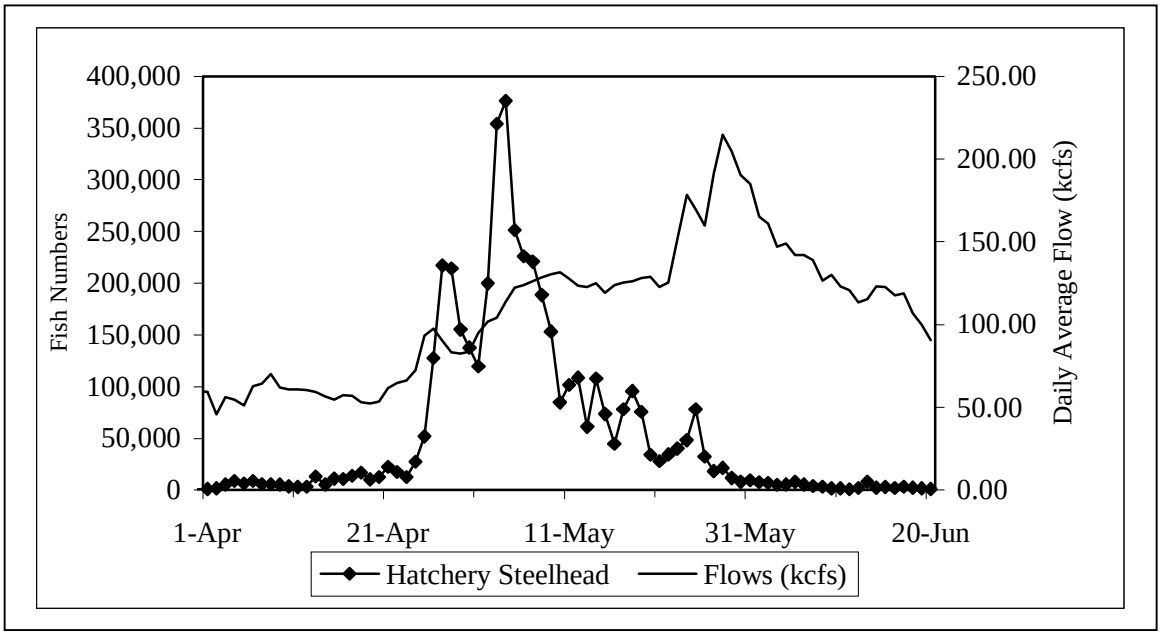


Figure 21. Daily hatchery steelhead collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.

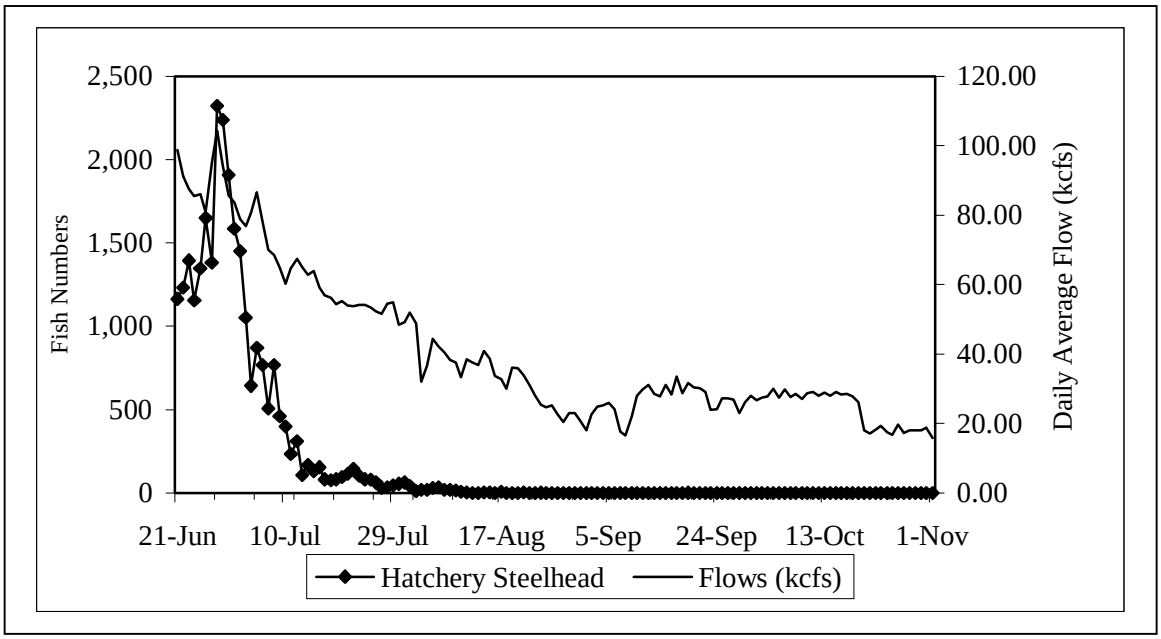


Figure 22. Daily wild steelhead collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

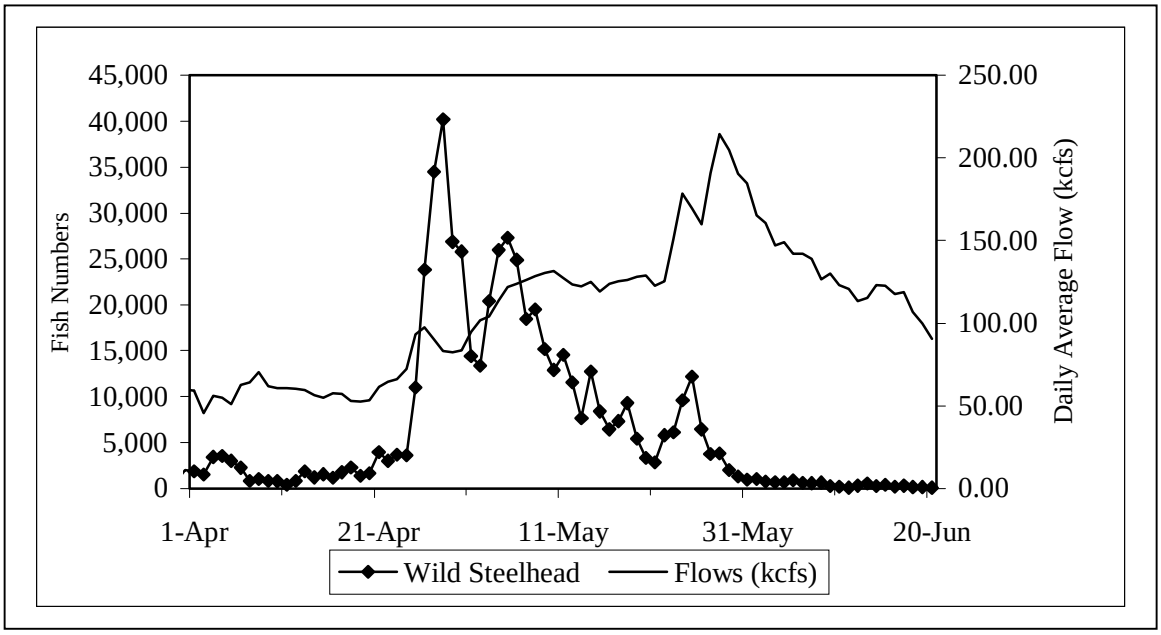


Figure 23. Daily wild steelhead collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.

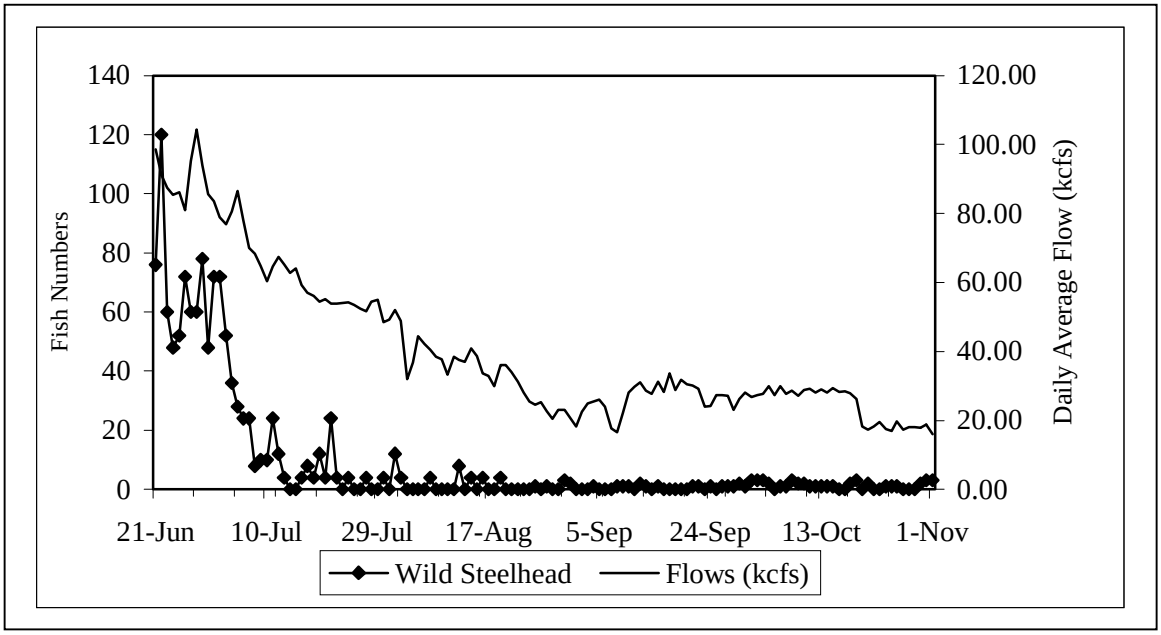


Figure 24. Daily hatchery coho collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

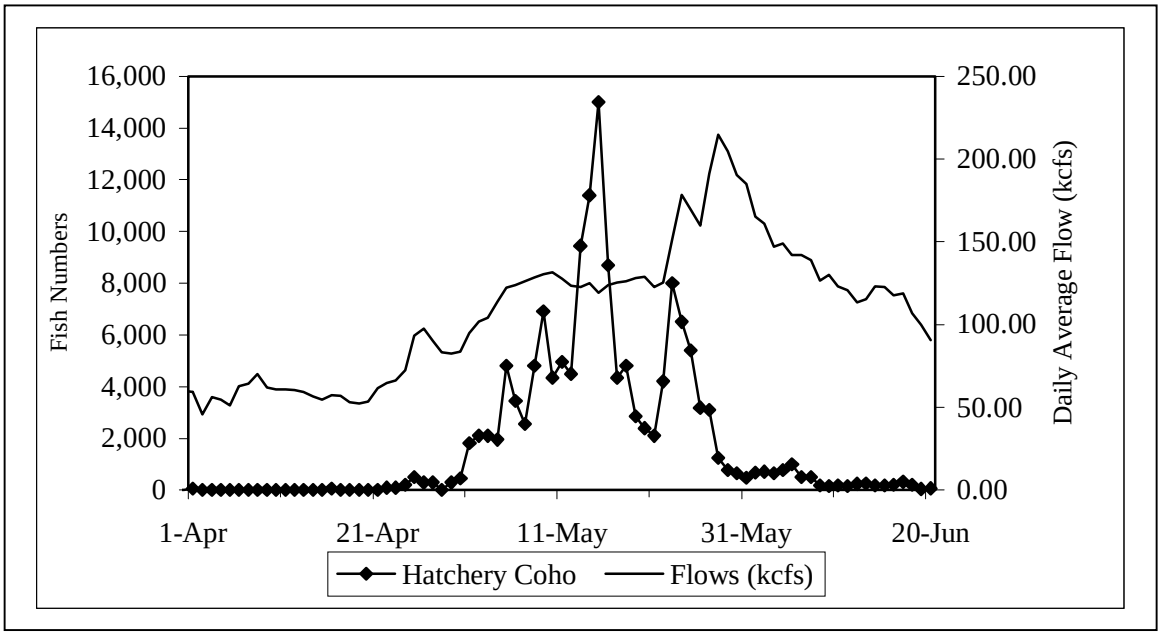


Figure 25. Daily hatchery coho collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.

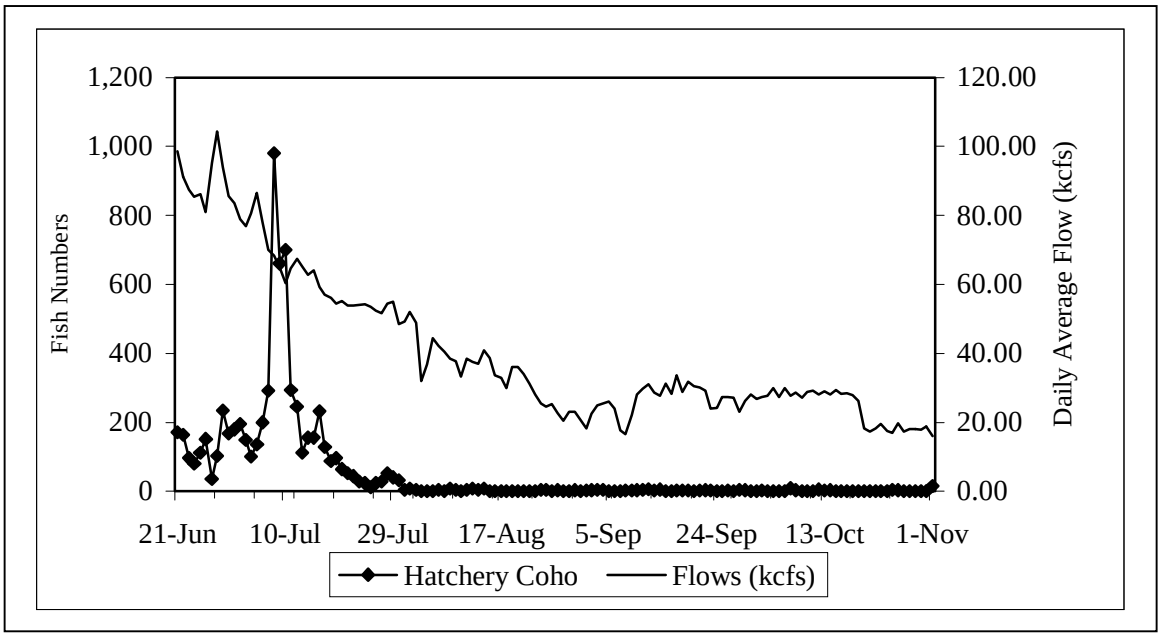


Figure 26. Daily hatchery sockeye/kokanee collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

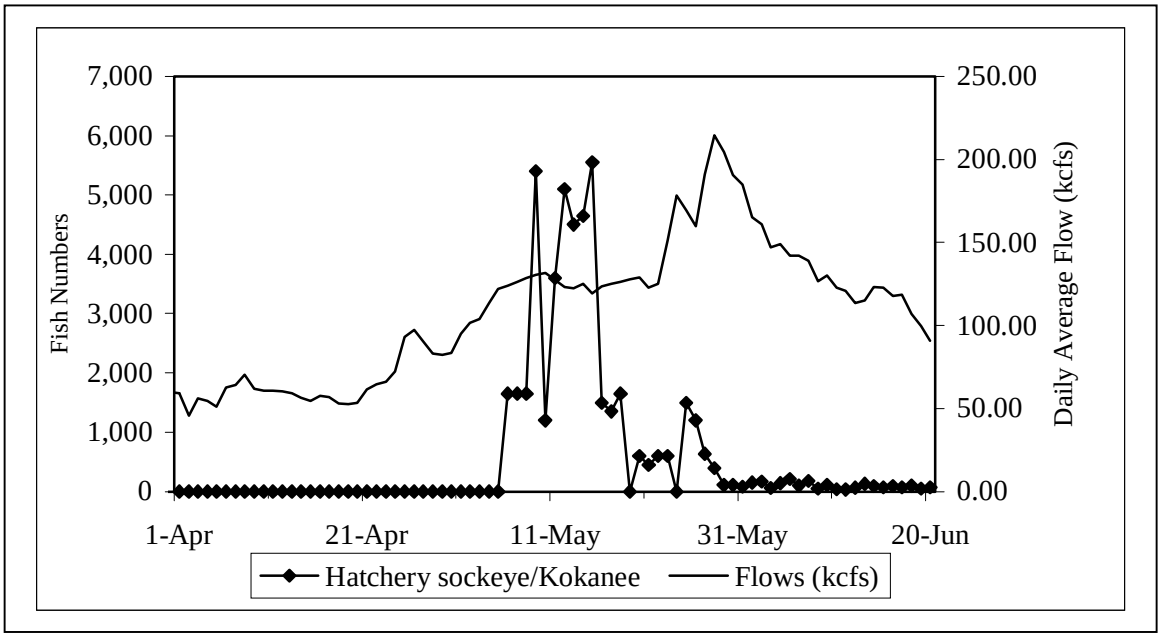


Figure 27. Daily hatchery sockeye/kokanee collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.

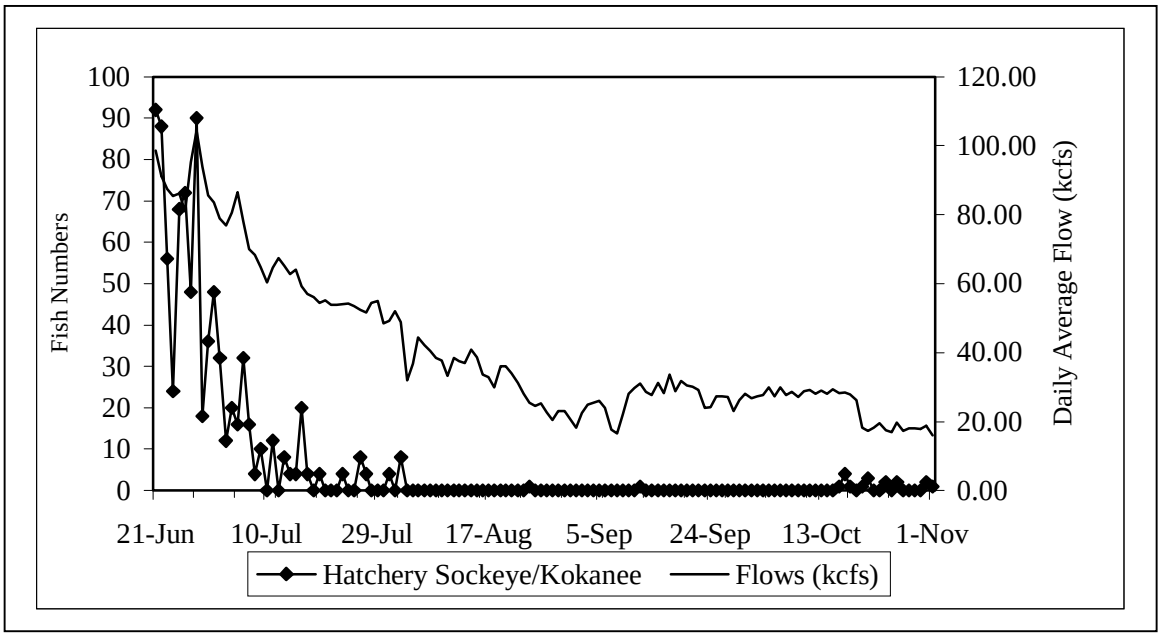


Figure 28. Daily wild sockeye/kokanee collection and river flow at Lower Granite Dam from April 1 through June 20, 1998.

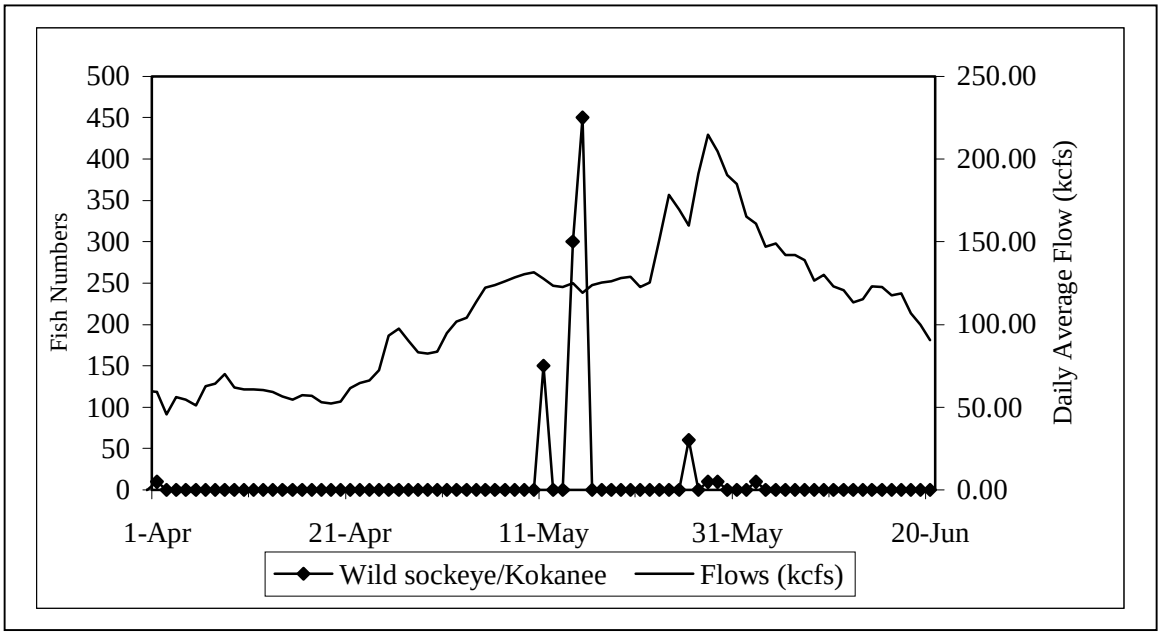
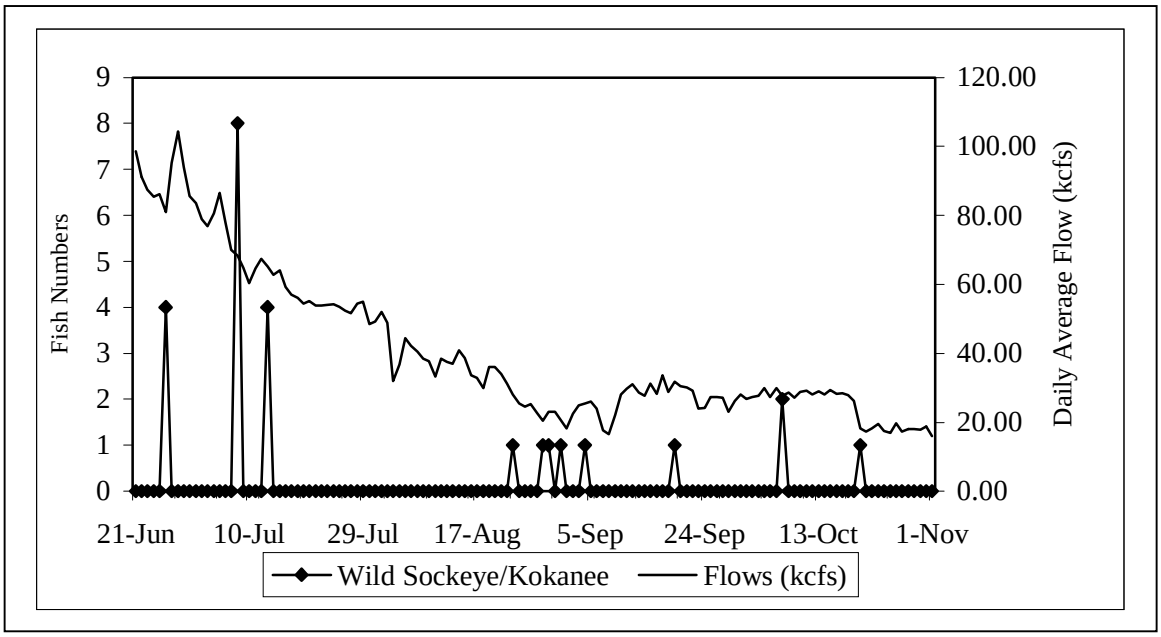


Figure 29. Daily wild sockeye/kokanee collection and river flow at Lower Granite Dam from June 21 through Nov. 1, 1998.



Transportation

An estimated 6,729,707 juvenile salmonids were transported from Lower Granite Dam in 1998 (Table 18), 96.5% of all fish collected. The number of fish by species were: 1,225,569 hatchery yearling chinook (93.0%), 266,153 wild yearling chinook (92.7%), 507 hatchery sub-yearling chinook (97.5%), 78,303 wild subyearling chinook (96.3%), 4,416,532 hatchery steelhead (97.5%), 539,512 wild steelhead (96.7%), 48,534 hatchery sockeye/kokanee (99.8%), 1,022 wild sockeye/kokanee (99.7%), and 153,575 hatchery coho (98.7%).

The transport season began with trucks, switched to barges as fish numbers increased and then back to trucks when fish numbers declined. The first truck left Lower Granite on March 28. Subsequent trucks left every other day through April 7. The first barge departed Lower Granite on April 9 and continued every other day through April 23. Barges left every day from April 25 through May 20, and then every other day through June 24. The barge season was extended to comply with the NMFS Biological Opinion about two weeks this year compared to 1997 when the last barge departed on June 10. Trucking resumed on June 26 and continued every-other-day until November 1. The 3,500 gallon trailers were used during the early season trucking phase and also in the late season trucking phase up to August 27, when the 150 gallon pickup-mounted mini-tanker was brought into use for the rest of the season. Daily truck and barge numbers, by species and total fish, can be found in Appendix 1, Table 2.

Approximately 2.8% of the fish transported in 1998, 187,305 juvenile salmonids, were transported by truck (Table 18). The percentages of the total transported for each species group that were transported by truck were: hatchery yearling chinook (1.8%), wild yearling chinook (7.6%), hatchery subyearling chinook (3.5%), wild subyearling chinook (89.7%), hatchery steelhead (1.1%), wild steelhead (3.4%), hatchery sockeye/kokanee (1.3%), wild sockeye/kokanee (3.1%), and hatchery coho (4.2%).

An estimated 6,542,402 juvenile salmonids, 97.2% of transported fish, were barged from Lower Granite Dam in 1998 (Table 18). The number of fish by species were: 1,203,805 hatchery yearling chinook (98.2%), 245,809wild yearling chinook (92.3%), 489 hatchery subyearling chinook (96.4%), 8,043 wild sub-yearling chinook (10.3%), 4,366,901 hatchery steelhead (98.9%), 521,297 wild steelhead (96.6%), 47,921 hatchery sockeye/kokanee (98.7%), 990 wild sockeye/kokanee (96.9%), and 147,145 hatchery coho (95.8%).

Fish collected at Little Goose Dam, Lower Monumental Dam and McNary Dam were loaded onto barges that originated from Lower Granite Dam during the season. The total number of fish barged from these other sites included: Little Goose Dam, 2,430,713; Lower Monumental Dam, 1,463,339; McNary Dam, 1,545,720.

Bypass

Approximately 236,414 juvenile salmonids, 3.4% of the collection, were bypassed from Lower Granite for various reasons in 1998 (Table 18 and Appendix 1 Table 2). About half as many fish were bypassed in 1997. The numbers of fish bypassed and the percentages of the total collected by species include: 88,312 hatchery yearling chinook (6.7%), 20,074 wild yearling chinook (7.0%), 1,003 wild subyearling chinook (1.2%), 107,561 hatchery steelhead (2.4%), 17,990 wild steelhead (3.2%), and 1,474coho (0.9%). No hatchery subyearling fall chinook or sockeye/kokanee were bypassed in 1998.

Primary bypass (fish diverted directly back to the river) was initiated at Lower Granite on March 17 at 1300 hours and continued until 0700 hours on March 26 when collection began. When the facility is in primary bypass mode no estimates of the number of fish bypassed are possible. At 0700 hours on November 1, the system returned to primary bypass when collection for the transportation program ended. The facilities remained in primary bypass until December 16 when the entire bypass system was dewatered for the season.

The PIT tag diversion system was operated in the standard diversion mode from March 27 to June 10. During this time the sub-sample diversion gate overrode the PIT-tag diversion gate and any PIT-tagged fish present during a sub-sample diversion gate operation went to the sub-sample. Most of the PIT-tagged fish detected during this time period were bypassed. After June 10 the PIT-tag diversion system was set to divert all PIT-tagged fish and override the sub-sample diversion gate. Some PIT-tagged fish were sent to the raceways (for transportation) for research purposes. Some missed by the diversion system, were sent to either the raceways or the sample tank.

According to the PTAGIS database 133,236 PIT-tagged fish were detected at Lower Granite. Of these, 80,104 (60%) were bypassed through the PIT-tag diversion system, 50,045 (38%) were diverted to the raceways and were transported, 1,638 (1%) were diverted to sample tank, sampled and then transported, 1,449 (1%) were not detected at any of the exit monitors, bypass, raceway or sample (fish disposition unknown). The PIT-tagged fish bypassed included: 20,395 hatchery yearling chinook, 6,822 wild yearling chinook, 29,280 hatchery subyearling chinook, 116 wild subyearling chinook, 12,866 hatchery steelhead, 4,651 wild steelhead, 1,489 hatchery sockeye/kokanee, 57 wild sockeye/kokanee, 919 hatchery coho, 3,480 unknown chinook, 29 unknown steelhead. A total of 47,089 PIT-tagged hatchery yearling chinook were diverted to raceways. An unknown number of non-tagged fish were also bypassed by the PIT-tag diversion system along with the tagged fish.

There were several events that resulted in fish being released back to the river either directly from the separator or after they had been loaded into raceways. The first event occurred between 1400 hours on April 4 and 0700 hours on April 5 when collection numbers exceeded the capacity of the available trucks. During this period, an estimated 13,980 fish, about half chinook and half steelhead, were bypassed to the river. Fish were bypassed because of lack of truck space for 25 hours from April 6 at 0600 to April 7 at 0700 hours and a total of 12,871 fish were

bypassed. Collection in excess of facility capacity on May 5 resulted in the bypass of approximately 106,799 smolts collected between 0000 and 0430 hours. On May 13, approximately 29 fish, mostly steelhead, fell from the dewatering overflow section on the direct load line into the river after a debris plug had developed in the line. An unknown number of smolts were bypassed to the river on 22 May when the tailscreen of raceway 7 was pulled to clear the raceway of dead fish.

There were five research projects at Lower Granite in 1998 that handled, marked and released fish back to the river. The National Marine Fisheries Service Transportation Evaluation Study PIT-tagged and bypassed 61,145 hatchery and 10,284 wild yearling chinook. The NMFS Reach Survival Study PIT-tagged and bypassed 23,161 hatchery and 6,826 wild steelhead. The NMFS Little Goose Project Survival Study PIT-tagged an additional 1,599 hatchery yearling chinook that were trucked to release sites above Little Goose Dam. The United States Geological Survey Biological Research Division (USGS BRD) radio-tagged 97 wild subyearling chinook for their temperature telemetry study and released them into the Lower Granite tailrace. The USGS BRD also radio-tagged 294 wild subyearling chinook and released these fish upstream of Lower Granite Dam as part of the Surface Bypass and Collector Study.

Starting on 24 August and continuing through the end of the collection season, all steelhead and some coho were returned to the river to reduce loading densities in the mini-tanker. Many did not appear to be smolts and may residualize. These fish were held in the lab until they had recovered from the anesthesia and were then released off the end of the barge dock. A total of 18 hatchery steelhead, 58 wild steelhead and 48 hatchery coho were released in this manner. Between September 21 and 26, 523 wild subyearling chinook were bypassed from daily samples because fish collection exceeded the capacity of the mini-tanker. A summary of the numbers of fish bypassed from the raceways, sample, and research activities is included in Appendix 1, Table 2.

Fish Mortality

Mortality

The overall facility mortality rate for fish collected at Lower Granite in 1998 was 0.2% (Table 21), a total of 10,630 mortalities (Appendix 1, Table 3). Facility mortality includes fish removed from the raceways, barges or trucks before departure, sample mortalities and NMFS research mortalities. The combined rate is heavily influenced by hatchery steelhead as they make up the bulk of fish in the annual collection. Hatchery steelhead mortality rates for the last five years was 0.1% or less. Hatchery and wild yearling chinook mortality rates, 0.3% for each, were lower than most of the previous four years. The wild subyearling chinook mortality rate decreased from 3.6% in 1997 to 2.4% this year but was second highest in the last five years. Weekly subyearling chinook mortality rates were highest during the weeks ending 17 September and 15 October when mortality rates exceeded 10% (Table 22). High water temperatures and fish disease contributed to high rates of mortality late in the season. The hatchery and wild sockeye/kokanee annual mortality rates decreased from preceding years to 0.2% and 0.3%, respectively. Hatchery coho collection numbers increased from 1,517 last year to 155,546 and the mortality increased from 0.1% in 1997 to 0.3% this year.

The facility mortality counts include fish that perished during research conducted by the National Marine Fisheries Service. Mortalities recorded during the Transportation and Survival Study included: 406 hatchery yearling chinook, 12 wild yearling chinook, two hatchery fall yearling chinook, 252 hatchery steelhead, 11 wild steelhead and five hatchery sockeye/kokanee. These fish represent less than 0.1% of the total facility mortality for 1998.

The total sample mortality rate in 1998 of 1.9% was the highest rate in the last five years (Table 23). Hatchery and wild steelhead sample mortality rates nearly doubled form the previous year while chinook and hatchery coho rates decreased. The wild subyearling chinook mortality rate decreased from 5.7% in 1997 to 4.7% in 1998.

Barge mortalities includes fish removed from barge holds after the barge has departed the loading dock at Lower Granite. Mortalities are included from fish loaded at Lower Granite, Little Goose, Lower Monumental and McNary Dams. The total barge mortality rate for 1998 was 0.06% (a total of 7,728 mortalities out of 11,982,174 barged fish), including 4,546 hatchery yearling chinook, 851 wild yearling chinook, 530 wild subyearling chinook, 1,391 hatchery steelhead, 210 wild steelhead, 190 coho, six hatchery and four wild sockeye/kokanee. There were no incidents or accidents on the barges that resulted in additional numbers of barge mortalities in 1998.

The overall mortality rate for fish trucked from Lower Granite Dam in 1998 was 0.5% (a total of 942 mortalities out of 187,305 trucked fish), compared to 0.2% (464) for 1997. This includes fish trucked prior to barging and fish trucked during the late season ending on November 1. Total mortality numbers by species were as follows: hatchery yearling chinook 93; wild yearling chinook 106; wild subyearling fall chinook 438; hatchery steelhead 233;

wild steelhead 49; hatchery sockeye/kokanee, 1 and hatchery coho 22.

Table 21. Annual facility mortality rate (%) at Lower Granite Dam, 1994-1998.

	Yearling Chinook		Subyearling[1] Chinook		Steelhead		Sockeye/Kokanee[2]		Coho[3]	
Year	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Total
1994	0.4	0.4	---	0.6	0.1	<0.1	---	3.0	---	0.2
1995	0.3	0.2	---	0.4	<0.1	<0.1	0.0	1.1	---	0.1
1996	0.6	0.9	---	1.4	<0.1	<0.1	0.4	5.1	0.1	0.1
1997	0.9	0.7	2.2	3.6	<0.1	<0.1	2.9	1.4	0.1	0.2
1998	0.3	0.3	2.5	2.4	<0.1	<0.1	0.2	0.3	0.3	0.2

[1]Hatchery subyearling chinook were not present until 1997.
[2]Hatchery sockeye/kokanee were not present until 1995.
[3]Hatchery coho were not present until 1996.

Table 22. Facility mortality rate (%) by week at Lower Granite Dam, 1998.

Week Ending	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Total
2-Apr	1.0	1.7	---	0.0	0.5	0.8	---	0.0	8.0	0.9
9-Apr	0.2	0.2	---	0.0	0.0	0.1	---	---	5.4	0.1
16-Apr	0.6	0.7	---	0.0	0.1	0.0	---	---	0.9	0.4
23-Apr	0.2	0.5	---	---	0.0	0.0	---	---	0.0	0.1
30-Apr	0.1	0.1	---	0.0	0.0	0.0	---	---	0.0	0.0
7-May	0.1	0.1	---	0.0	0.0	0.0	0.0	---	0.2	0.0
14-May	0.2	0.2	---	0.3	0.1	0.1	0.0	0.0	0.0	0.1
21-May	0.1	0.0	---	0.0	0.1	0.1	0.0	0.0	0.0	0.1
28-May	1.1	0.7	---	0.2	0.3	0.3	0.0	0.0	0.6	0.4
4-Jun	1.6	2.3	0.0	0.1	0.3	0.2	0.0	0.0	0.6	0.3
11-Jun	2.7	2.5	0.7	1.7	0.6	0.8	0.0	---	1.1	0.8
18-Jun	2.6	2.4	3.7	0.6	1.3	1.7	0.0	---	1.3	1.3
25-Jun	1.7	0.6	4.3	1.0	1.4	1.5	4.4	---	1.9	1.3
2-Jul	2.2	0.8	---	1.2	1.1	1.1	0.9	0.0	0.8	1.2
9-Jul	0.1	0.2	---	0.3	0.2	0.6	0.0	0.0	0.6	0.3
16-Jul	2.6	7.7	---	1.4	1.1	0.0	0.0	0.0	2.4	1.6
23-Jul	1.7	3.7	---	0.7	1.7	0.0	0.0	---	0.4	0.8
30-Jul	3.5	0.9	---	1.6	1.5	0.0	0.0	---	2.4	1.7
6-Aug	1.2	0.7	---	1.0	0.5	0.0	0.0	---	0.0	1.0
13-Aug	3.8	0.0	---	1.4	1.5	0.0	0.0	---	3.6	1.5
20-Aug	4.0	5.6	---	1.5	0.0	8.3	0.0	---	0.0	1.7
27-Aug	0.0	0.0	---	0.4	0.0	0.0	0.0	0.0	0.0	0.4
3-Sep	0.0	10.5	---	3.2	100.0	0.0	0.0	0.0	6.7	3.5
10-Sep	9.4	0.0	---	6.0	0.0	0.0	0.0	0.0	7.7	6.1
17-Sep	10.0	0.0	---	10.6	33.3	0.0	0.0	---	23.8	10.8
24-Sep	4.6	0.0	---	3.1	0.0	33.3	0.0	---	16.7	3.3
1-Oct	17.9	0.0	---	13.2	0.0	33.3	---	---	27.3	13.4
8-Oct	3.3	---	---	14.2	---	23.1	---	0.0	6.3	13.9
15-Oct	0.6	0.0	---	13.0	0.0	0.0	---	---	9.1	9.8
22-Oct	0.4	0.0	---	4.5	0.0	0.0	0.0	0.0	0.0	2.3
29-Oct	1.5	0.0	---	0.0	---	---	0.0	---	10.0	1.2
1-Nov	0.9	0.0	---	0.0	0.0	0.0	0.0	0.0	0.0	0.5

---No fish collected during the week.

Table 23. Annual sample mortality rate (%) at Lower Granite Dam, 1994-1998.

	Yearling Chinook		Subyearling[1] Chinook		Steelhead		Sockeye/Kokanee[2]		Coho[3]	
Year	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Total
1994	0.4	0.4	---	0.6	0.1	<0.1	---	3.0	---	0.2
1995	1.0	0.9	---	1.1	0.3	0.1	0.0	2.7	---	0.6
1996	1.9	2.3	---	2.7	0.3	0.2	0.8	13.2	0.2	0.8
1997	2.5	3.1	3.9	5.7	0.4	0.4	1.9	6.7	20.6	1.6
1998	1.8	2.2	2.4	4.7	0.8	0.7	2.7	11.5	2.4	1.9

[1]Hatchery subyearling chinook were not present until 1997.
[2] Hatchery sockeye/kokanee were not present until 1995
[3]Hatchery coho were not present until 1996.

Research

A total of 514,401 smolts were collected and handled at the Lower Granite Dam Juvenile Fish Facility this season to accommodate thirteen different research projects. Researchers tagged 148,674 smolts with PIT tags for three studies. A total of 616 radio tags were surgically implanted in yearling and sub-yearling chinook smolts. Researchers examined 9,096 smolts, sacrificed 461 yearling chinook, 119 steelhead and reported 60 incidental mortalities. One hundred and fifty four PIT-tagged fish were handled in the process of collecting smolts for the Gas Bubble Trauma exams. Another 357,001 smolts were handled to meet research project needs.

USGS-BRD Summer SBC Evaluation

The United States Geological Survey Biological Research Division (USGS-BRD) researchers tagged 294 wild subyearling chinook with radio tags from June 30 to July 10 for the summer test of the Surface and Bypass Collector. The radio tags were surgically implanted in the test fish. The fish were transported to the upstream release site, held for 24 hours, tagged, held for 24 hours to recover and then released. These tagged fish were then tracked as they approached the surface collector structure attached to the north half of the face of the powerhouse. An additional 36 wild subyearling chinook were handled and released and eight wild subyearling chinook perished during the summer evaluation period.

USGS-BRD Fall Chinook Temperature Telemetry

The United States Geological Survey Biological Research Division (USGS-BRD) researchers surgically implanted temperature transmitting radio tags in 97 wild subyearling chinook. These fish were tagged, held for 24 hours to recover and then released through the PIT tag bypass line back to the river from July 10 to September 2. Boat crews tracked these fish as they traveled through the Little Goose pool. Forty-one wild subyearling chinook were handled but not radio tagged. One smolt mortality was recorded during this research.

WDFW Gas Bubble Trauma Monitoring

The Washington Department of Fish and Wildlife (WDFW) conducted Gas Bubble Trauma (GBT) examinations on fish collected from the wet separator on Mondays, Wednesdays, and Fridays from April 7 through June 30. The examinations required inspections of the unpaired fins, lateral line, and eyes on both sides of the head with a dissecting microscope for signs of gas bubbles. Up to 100 chinook (hatchery and wild) and up to 100 steelhead (hatchery and wild), depending upon the numbers of fish available, were examined each day for GBT symptoms. For the season, a total of 5,695 salmonids were examined. This total included 1,649 hatchery yearling chinook, 442 wild yearling chinook, 3,044 hatchery steelhead and 560 wild steelhead. Another 782 smolts were handled while collecting samples from the separator including 151 PIT tagged smolts. These smolts were returned to the separator. There were 48 yearling chinook and 49 steelhead observed with symptoms of GBT.

NMFS Hatchery Subyearling Fall Chinook Survival Study: Diversion-by-code

The National Marine Fisheries Service (NMFS) collected PIT-tagged hatchery subyearling fall chinook, using the diversion by code system, to examine and release at two sites below the dam to study survival to downstream projects. Researchers diverted 2,050 tagged hatchery subyearling chinook for used 2,050 in the study. An additional 331 smolts were handled but not used in the study including 327 subyearling chinook and four hatchery steelhead. Thirty-two hatchery subyearling chinook recorded as mortalities during the study. Mortality counts were not applied to daily calculations for transportation because hatchery subyearling chinook were not represented in daily samples. Subtracting these fish from daily collection totals results in negative transport figures.

NMFS Little Goose Project Evaluation

The National Marine Fisheries Service (NMFS) tagged hatchery yearling chinook with PIT tags to determine survival rates of marked fish through the bypass system, turbines and spillways of Little Goose Dam. NMFS staff tagged 1,599 hatchery yearling chinook from April 29 to May 17. These fish were held for 24 hours after tagging and then trucked to release sites above Little Goose Dam.

NMFS Reach Survival Study

The National Marine Fisheries Service (NMFS) PIT-tagged hatchery and wild steelhead to determine survival rates through reservoir reaches below Lower Granite Dam. A total of 23,347 hatchery and 6,850 wild steelhead were PIT-tagged and bypassed to the river from April 7 to June 6. These fish were held for 24 hours after tagging and then released back to the river through the PIT-tag bypass line.

NMFS Transport Evaluation Marking Study

The National Marine Fisheries Service (NMFS) tagged a total of 116,878 smolts with PIT tags for the transportation evaluation study during the spring migration from April 7 to June 30. A total of 38,757 hatchery and 6,692 wild yearling chinook were tagged, transported and released below Bonneville Dam. NMFS staff tagged 61,145 hatchery and 10,284 wild yearling chinook. These smolts were held for 24 hours after tagging and then released via the PIT tag bypass line to continue their in-river migration. An additional 8,267 hatchery yearling chinook, 402 wild yearling chinook, 10,421 hatchery fall yearling chinook, 71 wild subyearling fall chinook, 295,583 hatchery steelhead, 35,441 wild steelhead, 2009 hatchery coho, 1,913 hatchery sockeye/kokanee and 20 wild sockeye/kokanee were handled but not marked. Since last year, NMFS modified the mechanical system used to deliver fish from the raceway to the marking trailer which allowed them to divert many steelhead directly back to a raceway without additional handling. Mortalities removed from raceways used by the study before and after tagging were counted as facility raceway mortalities and research mortalities. Mortalities recorded during the study included 406 hatchery yearling chinook, 12 wild yearling chinook, two hatchery fall yearling chinook, 252 hatchery steelhead, 11 wild steelhead and five hatchery sockeye/kokanee.

OSU Evaluation of Fish Facilities and Transportation Study: Radio telemetry

The Oregon State University Fishery Cooperative Fishery Research Unit (OSUCFRU) researchers surgically implanted radio tags in hatchery yearling chinook to study their migration behavior and survival following their release below Bonneville Dam from the transportation barges. These fish were collected from the wet separator at Lower Granite Dam from April 30 through May 31. A total of 225 hatchery yearling chinook were tagged and tracked from the barge release site to the estuary. Eighty-five hatchery yearling chinook were sacrificed for physiological indices. An additional 452 smolts including 159 yearling chinook, 234 steelhead, 38 coho and 21 hatchery sockeye were handled but not utilized for this research. Mortalities included eight hatchery yearling chinook and one hatchery sockeye/kokanee.

U of I Hatchery/Wild Comparison Study: Gatewell sampling

University of Idaho Fishery Co-Op researchers collected study fish from gatewell slots at the dam, a location fish pass prior to entering the juvenile fish collection system. Fish counts from this study were not attributed to collection facility counts because they were taken before entering the collection system. Researchers used a dip basket to collect a total of 779 smolts including 109 hatchery and 18 wild yearling chinook and 637 hatchery and 15 wild steelhead. Of these, researchers sacrificed 71 hatchery and 16 wild yearling chinook and 43 hatchery and 15 wild steelhead for this study.

U of I Hatchery/Wild Comparison Study: Long-term holding trials

University of Idaho Fishery Co-Op researchers collected a total of 306 smolts from daily samples to evaluate physiological indices over period of about two months. Researches periodically sacrificed a portion of the test fish throughout the period. A total of 297 smolts were sacrificed during this study including 196 hatchery and 40 wild and 31 hatchery and 30 wild steelhead. Incidental mortalities during the experiment included four hatchery and five wild yearling chinook.

U of I In-Flume Separator Study

University of Idaho Fishery Co-Op researchers tested the efficiency of secondary in-flume separators for large and small smolts in 1997 and 1998. In 1998, a total of 1,849 smolts were diverted to the flume with the in-flume separator including 79 hatchery yearling chinook, 1,762 hatchery steelhead, five hatchery coho, and three hatchery sockeye/kokanee. Separator lengths of 2 meters and 3.5 meters were tested in 1998, and no significant differences were found between the two configurations. However, results of 1997 and 1998 comparison tests indicated that separation efficiency increased in proportion to separator length, and the 3.5 meter separator was about 80% efficient in separating small and large smolts in 1998 tests.

U of I Yearling Chinook Hatchery Release Evaluation: Diversion by code

University of Idaho Fishery Co-Op researchers collected a total of 62 smolts using the PIT tag diversion by code system. PIT-tagged fish from different hatchery release groups were selectively diverted to a holding tank. A total of 53 hatchery yearling chinook were sacrificed to measure physiological indices. Seven hatchery steelhead were handled and released and one chinook was recorded as mortality.

USFWS Fall Chinook Study

USFWS staff collected length, weight and scale samples from a select sample of 68 yearling chinook between March 30 and April 8 to look for and identify possible yearling fall chinook in the sample. Another fourteen wild yearling chinook were handled and not sampled.

Recommendations

1. Install two indoor recovery tanks in the sample lab to (1) hold fish after sampling on non-transport days and (2) hold fish to bypass in freshwater for recovery from anesthesia prior to release.

2. Truck sanitizing chemicals: change from powdered chlorine to liquid to decrease health risk, chlorine dust and equipment oxidation.

3. Fabricate a screen for the large tanker to prevent fish from jumping out while the hatch is open during loading.

4. Install a limit switch in the bypass gate of the East raceway load flume to indicate exact times of bypass. Re: Scott Livingston, PSMFC

5. Install a false bottom inside truck mini-tank that has a positive slope toward the exit drain to facilitate efficient unloading at the release site.

6. Install a "bucket-filler" valve near the sorting tank in the sample lab.

7. Replace the sample to barge load line hose with lighter weight flexible hose to reduce physical strain and possible work hazard.

8. Install storage cabinets (or shelves) in the chiller room.

9. Modify through-the-wall sample direct-load line to provide slope and prevent fish stranding.

10. Install bleeder valve in lowest section of pipe that returns water from the sorting tank to the lower sump in the chiller room to prevent anaerobic bacterial production of hydrogen sulfide gas when the sorting tank system is off.

11. Record hatchery/wild origin of adult chinook removed from the separator.

12. Improve GBT handlog to match FPC16 data entry program.

Appendix

Table 1. Daily Smolt Collection Counts, River Flows and Temperature at Lower Granite Dam, 1998.

	Daily Smolt Collection Counts											River Conditions		
	Yearling Chinook		Sub-yr Chinook		Steelhead		Coho	Sockeye/Kokanee		Daily	Cumulative	River	Spill	Temp.
Date	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Unk	Hatchery	Wild	Total	Total	(kcfs)	(kcfs)	(F)
27-Mar	40	40	0	0	20	70	10	0	0	180	180	75.4	6.1	46.9
28-Mar	90	120	0	10	100	620	0	0	0	940	1,120	80.8	9.9	46.8
29-Mar	30	70	0	10	70	700	10	0	0	890	2,010	61.3	0.0	46.8
30-Mar	210	140	0	0	90	720	10	0	0	1,170	3,180	60.4	0.0	46.8
31-Mar	380	220	0	10	510	2,020	0	0	0	3,140	6,320	60.0	0.0	47.3
1-Apr	720	270	0	0	950	1,850	60	0	10	3,860	10,180	59.2	0.0	47.3
2-Apr	650	530	0	0	1,770	1,490	10	0	0	4,450	14,630	45.6	0.0	47.3
3-Apr	1,820	2,200	0	0	5,290	3,420	20	0	0	12,750	27,380	56.0	0.0	47.3
4-Apr	3,226	3,761	0	0	8,537	3,536	14	0	0	19,074	46,454	54.8	0.0	47.3
5-Apr	4,740	5,300	0	20	6,240	3,000	20	0	0	19,320	65,774	50.9	0.0	48.2
6-Apr	7,050	6,210	0	10	9,050	2,270	0	0	0	24,590	90,364	62.8	0.0	48.2
7-Apr	3,074	3,006	0	20	5,826	854	0	0	0	12,780	103,144	64.3	14.5	48.2
8-Apr	3,180	1,900	0	0	5,540	1,000	0	0	0	11,620	114,764	70.3	26.4	48.2
9-Apr	1,984	1,280	0	0	5,509	851	20	0	0	9,644	124,408	61.9	28.9	49.1
10-Apr	2,460	1,620	0	20	3,560	800	20	0	0	8,480	132,888	60.6	28.9	49.1
11-Apr	2,576	1,564	0	0	3,063	437	20	0	0	7,660	140,548	60.6	28.9	49.3
12-Apr	3,520	1,540	0	0	3,360	840	0	0	0	9,260	149,808	60.3	23.4	49.3
13-Apr	4,360	1,600	0	0	12,920	1,900	20	0	0	20,800	170,608	59.4	23.5	49.6
14-Apr	6,480	2,040	0	20	5,585	1,215	0	0	0	15,340	185,948	56.4	5.8	49.6
15-Apr	16,820	6,140	0	0	11,060	1,560	0	0	0	35,580	221,528	54.9	5.7	50.0
16-Apr	11,433	4,417	0	0	10,845	1,155	50	0	0	27,900	249,428	57.5	6.0	50.0
17-Apr	11,200	4,450	0	0	13,700	1,750	0	0	0	31,100	280,528	57.2	6.0	50.0
18-Apr	12,132	3,768	0	0	16,888	2,305	0	0	0	35,093	315,621	52.8	6.0	50.0
19-Apr	20,650	4,400	0	0	10,350	1,350	0	0	0	36,750	352,371	52.4	6.0	50.0
20-Apr	18,700	3,350	0	0	12,650	1,650	0	0	0	36,350	388,721	53.2	6.0	50.0
21-Apr	42,736	8,214	0	0	22,642	3,958	0	0	0	77,550	466,271	61.6	6.0	50.5
22-Apr	48,150	7,900	0	0	17,300	3,000	100	0	0	76,450	542,721	64.7	9.5	51.8
23-Apr	46,993	8,507	0	0	12,789	3,711	100	0	0	72,100	614,821	66.1	7.4	52.0
24-Apr	58,700	6,100	0	100	27,500	3,600	200	0	0	96,200	711,021	72.4	5.5	52.0
25-Apr	67,190	7,710	0	0	52,087	11,013	500	0	0	138,500	849,521	93.2	26.5	52.7
26-Apr	66,900	7,500	0	0	127,400	23,800	300	0	0	225,900	1,075,421	97.4	30.9	52.7
27-Apr	60,000	8,100	0	0	217,050	34,500	300	0	0	319,950	1,395,371	90.4	23.4	51.8
28-Apr	63,539	9,611	0	0	213,980	40,220	0	0	0	327,350	1,722,721	83.3	16.5	51.8
29-Apr	36,150	7,500	0	1,050	155,250	26,850	300	0	0	227,100	1,949,821	82.4	15.7	50.9
30-Apr	47,123	6,757	0	0	137,776	25,824	450	0	0	217,930	2,167,751	83.7	16.9	51.8
1-May	40,950	4,650	0	0	119,550	14,400	1,800	0	0	181,350	2,349,101	95.0	28.4	52.7
2-May	63,687	10,363	0	0	199,880	13,370	2,100	0	0	289,400	2,638,501	101.6	34.7	53.6
3-May	66,750	19,050	0	0	353,700	20,400	2,100	0	0	462,000	3,100,501	104.2	28.6	53.6
4-May	70,950	14,700	0	0	375,900	25,950	1,950	0	0	489,450	3,589,951	113.8	28.4	55.4
5-May	70,141	9,909	0	0	251,333	27,317	4,800	0	0	363,500	3,953,451	122.0	31.4	55.4
6-May	56,139	11,400	0	0	226,200	24,900	3,450	1,650	0	323,739	4,277,190	124.0	30.6	55.4
7-May	43,893	6,607	0	0	220,877	18,473	2,550	1,650	0	294,050	4,571,240	126.2	32.7	55.4
8-May	25,080	5,550	0	450	188,550	19,500	4,800	1,650	0	245,580	4,816,820	128.5	31.8	55.2
9-May	37,739	8,111	0	150	153,369	15,181	6,900	5,400	0	226,850	5,043,670	130.3	33.9	55.2
10-May	41,550	7,950	0	150	84,750	12,900	4,350	1,200	0	152,850	5,196,520	131.5	35.5	54.3
11-May	18,300	4,350	0	0	101,700	14,550	4,950	3,600	150	147,600	5,344,120	127.5	30.6	53.6
12-May	14,636	3,914	0	0	108,812	11,588	4,500	5,100	0	148,550	5,492,670	123.3	29.2	54.5
13-May	16,500	3,750	0	0	61,350	7,650	9,450	4,500	0	103,200	5,595,870	122.6	29.2	55.4

14-May	17,674	3,311	0	0	107,924	12,776	11,400	4,650	300	158,035	5,753,905	125.0	29.3	55.4
15-May	14,250	2,400	0	0	73,500	8,400	15,000	5,550	450	119,550	5,873,455	119.4	30.8	54.5
16-May	5,500	1,981	0	0	44,919	6,481	8,700	1,500	0	69,081	5,942,536	123.8	30.8	53.6

Table 1. Daily Smolt Collection Counts, River Flows and Temperature at Lower Granite Dam, 1998.

	Daily Smolt Collection Counts											River Conditions		
	Yearling Chinook		Sub-yr Chinook		Steelhead		Coho	Sockeye/Kokanee		Daily	Cumulative	River	Spill	Temp.
Date	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Unk	Hatchery	Wild	Total	Total	(kcfs)	(kcfs)	(F)
17-May	3,300	3,450	0	0	78,000	7,350	4,350	1,350	0	97,800	6,040,336	125.2	29.3	54.5
18-May	4,500	2,400	0	0	95,700	9,300	4,800	1,650	0	118,350	6,158,686	126.2	29.2	54.5
19-May	2,322	778	0	0	75,665	5,435	2,850	0	0	87,050	6,245,736	128.0	36.8	55.4
20-May	1,500	900	0	450	34,050	3,300	2,400	600	0	43,200	6,288,936	129.0	31.9	55.8
21-May	1,812	306	0	0	28,285	2,865	2,100	450	0	35,818	6,324,754	122.7	31.2	56.3
22-May	2,230	1,500	0	0	34,400	5,800	4,200	600	0	48,730	6,373,484	125.2	32.5	56.3
23-May	4,377	2,261	0	0	40,080	6,120	8,000	600	0	61,438	6,434,922	151.2	48.1	55.6
24-May	2,100	3,100	0	0	48,000	9,600	6,500	0	0	69,300	6,504,222	178.4	74.0	53.6
25-May	2,500	3,200	0	0	77,900	12,200	5,400	1,500	0	102,700	6,606,922	169.6	64.9	53.6
26-May	1,795	1,640	0	40	32,631	6,449	3,180	1,200	60	46,995	6,653,917	160.0	55.6	53.6
27-May	830	630	0	490	18,520	3,750	3,110	640	0	27,970	6,681,887	191.0	86.4	53.6
28-May	471	783	0	360	21,643	3,837	1,240	400	10	28,744	6,710,631	214.7	111.1	53.6
29-May	264	310	30	130	11,760	2,010	780	110	10	15,404	6,726,035	204.6	101.3	53.6
30-May	195	241	0	160	8,244	1,306	660	110	0	10,916	6,736,951	190.5	87.8	54.5
31-May	81	20	0	240	9,420	960	480	80	0	11,281	6,748,232	184.8	83.3	55.4
1-Jun	120	120	60	220	7,800	1,020	680	150	0	10,170	6,758,402	165.2	62.6	55.4
2-Jun	111	63	60	170	7,013	757	710	170	10	9,064	6,767,466	160.7	61.0	57.2
3-Jun	80	70	20	80	4,880	660	650	60	0	6,500	6,773,966	147.3	54.1	57.2
4-Jun	150	80	20	140	5,479	701	770	140	0	7,480	6,781,446	149.0	47.3	57.7
5-Jun	230	80	10	200	7,890	870	990	210	0	10,480	6,791,926	142.1	47.6	57.7
6-Jun	120	60	30	410	5,509	621	510	100	0	7,360	6,799,286	142.0	54.4	57.4
7-Jun	80	120	30	240	4,100	550	490	180	0	5,790	6,805,076	138.9	55.2	57.2
8-Jun	80	80	30	100	3,510	630	170	50	0	4,650	6,809,726	126.5	52.9	58.1
9-Jun	60	90	40	110	1,710	280	160	110	0	2,560	6,812,286	130.1	43.3	58.1
10-Jun	28	76	4	104	1,576	200	184	40	0	2,212	6,814,498	122.8	38.7	58.6
11-Jun	30	55	5	45	888	82	155	35	0	1,295	6,815,793	120.9	49.4	59.0
12-Jun	135	120	50	130	1,875	290	245	65	0	2,910	6,818,703	113.5	33.1	60.8
13-Jun	290	215	5	100	8,039	526	250	130	0	9,555	6,828,258	115.3	36.0	60.8
14-Jun	105	120	15	65	2,375	270	190	95	0	3,235	6,831,493	123.1	40.1	60.8
15-Jun	80	140	25	150	3,165	415	170	70	0	4,215	6,835,708	122.7	37.3	60.8
16-Jun	90	185	0	90	2,124	206	195	95	0	2,985	6,838,693	117.8	27.7	60.8
17-Jun	125	250	40	255	3,480	290	315	70	0	4,825	6,843,518	118.7	27.4	61.7
18-Jun	168	174	0	210	2,456	176	204	102	0	3,490	6,847,008	106.8	27.0	60.8
19-Jun	90	156	0	144	1,656	144	42	54	0	2,286	6,849,294	99.7	27.4	59.0
20-Jun	102	174	6	120	990	100	72	72	0	1,636	6,850,930	90.8	27.2	59.9
21-Jun	156	200	16	268	1,164	76	172	92	0	2,144	6,853,074	98.7	13.7	60.4
22-Jun	420	408	4	456	1,232	120	164	88	0	2,892	6,855,966	91.2	0.0	60.8
23-Jun	336	612	0	352	1,440	66	96	56	0	2,958	6,858,924	87.5	0.0	60.8
24-Jun	188	156	0	132	1,156	48	80	24	0	1,784	6,860,708	85.5	0.0	60.8
25-Jun	300	260	20	780	1,444	56	112	68	0	3,040	6,863,748	86.1	0.0	61.7
26-Jun	356	324	0	852	1,648	72	152	72	4	3,480	6,867,228	81.0	5.4	62.6
27-Jun	276	184	0	548	1,451	64	36	48	0	2,607	6,869,835	95.2	0.0	61.7
28-Jun	510	366	0	966	2,322	60	102	90	0	4,416	6,874,251	104.2	0.0	60.8
29-Jun	372	630	0	498	2,238	78	234	18	0	4,068	6,878,319	94.1	0.0	60.8
30-Jun	312	222	0	840	1,991	51	168	36	0	3,620	6,881,939	85.6	0.0	61.7
1-Jul	216	72	0	438	1,584	72	180	48	0	2,610	6,884,549	83.6	5.1	62.6
2-Jul	224	132	0	700	1,452	72	196	32	0	2,808	6,887,357	79.0	5.7	63.5

3-Jul	260	608	0	604	1,052	52	148	12	0	2,736	6,890,093	76.8	5.8	64.4
4-Jul	224	392	0	960	644	36	100	20	0	2,376	6,892,469	80.6	5.8	65.8
5-Jul	280	424	0	1,132	872	28	136	16	0	2,888	6,895,357	86.6	5.7	66.4
6-Jul	212	256	0	916	768	24	200	32	0	2,408	6,897,765	78.0	5.7	66.2
7-Jul	228	192	0	1,340	508	24	292	16	0	2,600	6,900,365	70.1	5.7	67.1

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	Daily Smolt Collection Counts											River Conditions		
	Yearling Chinook		Sub-yr Chinook		Steelhead		Coho	Sockeye/Kokanee		Daily	Cumulative	River	Spill	Temp.
Date	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Unk	Hatchery	Wild	Total	Total	(kcfs)	(kcfs)	(F)
8-Jul	652	920	0	5,668	768	8	980	4	8	9,008	6,909,373	68.4	5.8	68.0
9-Jul	240	290	0	6,210	460	10	660	10	0	7,880	6,917,253	64.8	5.7	68.0
10-Jul	80	20	0	2,580	400	10	700	0	0	3,790	6,921,043	60.3	5.7	69.8
11-Jul	72	18	0	1,896	234	24	294	12	0	2,550	6,923,593	64.6	5.7	69.8
12-Jul	66	12	0	2,028	312	12	246	0	0	2,676	6,926,269	67.3	5.8	70.7
13-Jul	36	8	0	780	108	4	112	8	4	1,060	6,927,329	65.1	5.8	69.8
14-Jul	52	4	0	2,040	168	0	156	4	0	2,424	6,929,753	62.8	5.8	68.9
15-Jul	36	4	0	2,620	132	0	156	4	0	2,952	6,932,705	64.0	5.8	68.9
16-Jul	44	12	0	2,288	156	4	232	20	0	2,756	6,935,461	59.2	5.7	68.0
17-Jul	48	12	0	2,276	84	8	128	4	0	2,560	6,938,021	57.0	3.8	68.4
18-Jul	20	44	0	1,656	76	4	88	0	0	1,888	6,939,909	56.1	5.6	68.9
19-Jul	48	12	0	1,224	84	12	96	4	0	1,480	6,941,389	54.4	0.0	69.6
20-Jul	28	28	0	1,212	96	4	64	0	0	1,432	6,942,821	55.2	0.0	68.9
21-Jul	48	32	0	1,076	116	24	52	0	0	1,348	6,944,169	53.9	2.1	69.8
22-Jul	40	24	0	1,164	148	4	44	0	0	1,424	6,945,593	53.8	0.0	70.7
23-Jul	68	36	0	1,040	104	0	28	4	0	1,280	6,946,873	54.1	0.0	69.8
24-Jul	36	24	0	836	84	4	24	0	0	1,008	6,947,881	54.3	0.0	69.8
25-Jul	28	8	0	884	80	0	12	0	0	1,012	6,948,893	53.6	0.0	68.0
26-Jul	20	16	0	840	64	0	24	8	0	972	6,949,865	52.4	0.0	69.8
27-Jul	32	8	0	1,016	32	4	28	4	0	1,124	6,950,989	51.6	0.0	69.8
28-Jul	24	28	0	460	36	0	52	0	0	600	6,951,589	54.5	0.0	69.8
29-Jul	60	24	0	912	48	0	40	0	0	1,084	6,952,673	55.0	0.0	70.3
30-Jul	32	4	0	700	56	4	32	0	0	828	6,953,501	48.5	0.0	69.4
31-Jul	68	56	0	696	64	0	4	4	0	892	6,954,393	49.2	0.0	69.4
1-Aug	64	20	0	772	44	12	8	0	0	920	6,955,313	52.0	0.0	68.5
2-Aug	32	32	0	476	12	4	4	8	0	568	6,955,881	48.8	0.0	68.2
3-Aug	16	4	0	272	20	0	0	0	0	312	6,956,193	32.0	0.0	68.9
4-Aug	36	24	0	336	20	0	0	0	0	416	6,956,609	36.7	0.0	69.8
5-Aug	32	8	0	436	32	0	0	0	0	508	6,957,117	44.4	0.0	70.5
6-Aug	52	4	0	588	36	0	4	0	0	684	6,957,801	42.2	0.0	71.6
7-Aug	56	4	0	1,068	20	4	0	0	0	1,152	6,958,953	40.4	0.0	70.7
8-Aug	48	8	0	896	20	0	8	0	0	980	6,959,933	38.4	0.0	71.6
9-Aug	24	12	0	500	16	0	4	0	0	556	6,960,489	37.7	0.0	71.6
10-Aug	24	16	0	424	8	0	0	0	0	472	6,960,961	33.3	0.0	70.7
11-Aug	8	8	0	432	4	0	4	0	0	456	6,961,417	38.5	0.0	70.7
12-Aug	4	8	0	652	0	8	8	0	0	680	6,962,097	37.6	0.0	68.9
13-Aug	20	4	0	448	0	0	4	0	0	476	6,962,573	36.9	0.0	69.6
14-Aug	8	8	0	512	4	4	8	0	0	544	6,963,117	40.9	0.0	70.3
15-Aug	24	24	0	616	4	0	0	0	0	668	6,963,785	38.7	0.0	69.1
16-Aug	24	16	0	620	0	4	0	0	0	664	6,964,449	33.7	0.0	68.5
17-Aug	12	0	0	472	8	0	0	0	0	492	6,964,941	32.9	0.0	69.8
18-Aug	4	20	0	448	0	0	0	0	0	472	6,965,413	30.0	0.0	69.8
19-Aug	4	4	0	396	0	4	0	0	0	408	6,965,821	36.0	0.0	68.9
20-Aug	0	0	0	372	0	0	0	0	0	372	6,966,193	36.0	0.0	69.8
21-Aug	12	0	0	292	4	0	0	0	0	308	6,966,501	34.0	0.0	68.0

22-Aug	7	0	0	175	1	0	0	0	0	183	6,966,684	31.2	0.0	67.1
23-Aug	9	1	0	134	1	0	0	0	1	146	6,966,830	28.0	0.0	67.1
24-Aug	6	5	0	161	2	0	4	1	0	179	6,967,009	25.5	0.0	67.1
25-Aug	6	8	0	130	1	1	4	0	0	150	6,967,159	24.6	0.0	66.6
26-Aug	13	0	0	138	0	0	1	0	0	152	6,967,311	25.2	0.0	67.5
27-Aug	8	1	0	164	1	1	3	0	0	178	6,967,489	22.7	0.0	66.2
28-Aug	4	0	0	165	1	0	1	0	1	172	6,967,661	20.5	0.0	67.1

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	Daily Smolt Collection Counts											River Conditions		
	Yearling Chinook		Sub-yr Chinook		Steelhead		Coho	Sockeye/Kokanee		Daily	Cumulative	River	Spill	Temp.
Date	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Unk	Hatchery	Wild	Total	Total	(kcfs)	(kcfs)	(F)
29-Aug	7	2	0	133	0	0	1	0	1	144	6,967,805	23.1	0.0	69.1
30-Aug	11	3	0	130	0	3	3	0	0	150	6,967,955	23.1	0.0	68.0
31-Aug	5	9	0	159	0	2	1	0	1	177	6,968,132	20.7	0.0	68.9
1-Sep	4	0	0	87	0	0	2	0	0	93	6,968,225	18.2	0.0	69.8
2-Sep	1	4	0	60	0	0	3	0	0	68	6,968,293	22.6	0.0	70.7
3-Sep	3	1	0	37	0	0	4	0	0	45	6,968,338	24.9	0.0	71.6
4-Sep	2	2	0	30	0	1	4	0	1	40	6,968,378	25.4	0.0	71.6
5-Sep	2	0	0	32	1	0	1	0	0	36	6,968,414	26.0	0.0	72.5
6-Sep	0	0	0	24	0	0	1	0	0	25	6,968,439	24.1	0.0	72.5
7-Sep	7	1	0	46	1	0	0	0	0	55	6,968,494	17.7	0.0	72.5
8-Sep	5	1	0	77	0	1	2	0	0	86	6,968,580	16.6	0.0	72.5
9-Sep	9	2	0	131	0	1	2	0	0	145	6,968,725	22.1	0.0	73.4
10-Sep	7	0	0	108	0	1	3	0	0	119	6,968,844	28.0	0.0	73.4
11-Sep	5	2	0	174	1	0	4	0	0	186	6,969,030	29.8	0.0	73.4
12-Sep	6	2	0	128	0	2	6	1	0	145	6,969,175	31.1	0.0	72.9
13-Sep	8	3	0	103	1	1	2	0	0	118	6,969,293	28.7	0.0	72.5
14-Sep	3	2	0	60	0	0	5	0	0	70	6,969,363	27.8	0.0	72.5
15-Sep	2	2	0	65	0	1	1	0	0	71	6,969,434	31.2	0.0	72.5
16-Sep	4	0	0	61	0	0	1	0	0	66	6,969,500	28.3	0.0	72.5
17-Sep	2	0	0	40	1	0	2	0	0	45	6,969,545	33.6	0.0	73.4
18-Sep	1	3	0	62	0	0	2	0	0	68	6,969,613	28.8	0.0	71.6
19-Sep	6	3	0	90	2	0	2	0	1	104	6,969,717	31.8	0.0	71.6
20-Sep	5	1	0	106	1	0	1	0	0	114	6,969,831	30.5	0.0	71.6
21-Sep	1	0	0	218	0	1	2	0	0	222	6,970,053	30.2	0.0	70.7
22-Sep	2	2	0	356	1	1	3	0	0	365	6,970,418	29.1	0.0	70.7
23-Sep	3	5	0	429	0	0	2	0	0	439	6,970,857	23.9	0.0	70.7
24-Sep	4	1	0	402	0	1	0	0	0	408	6,971,265	24.2	0.0	70.0
25-Sep	5	0	0	355	0	0	0	0	0	360	6,971,625	27.3	0.0	69.8
26-Sep	3	0	0	343	0	1	2	0	0	349	6,971,974	27.3	0.0	68.9
27-Sep	4	1	0	208	1	1	0	0	0	215	6,972,189	27.1	0.0	68.4
28-Sep	7	0	0	222	1	1	4	0	0	235	6,972,424	23.0	0.0	68.4
29-Sep	1	0	0	295	0	2	3	0	0	301	6,972,725	26.2	0.0	68.9
30-Sep	6	0	0	314	0	1	1	0	0	322	6,973,047	28.1	0.0	68.0
1-Oct	2	1	0	295	1	3	1	0	0	303	6,973,350	26.7	0.0	68.0
2-Oct	4	2	0	321	0	3	2	0	0	332	6,973,682	27.4	0.0	68.0
3-Oct	4	0	0	332	0	3	1	0	0	340	6,974,022	27.8	0.0	67.1
4-Oct	3	0	0	237	0	2	0	0	0	242	6,974,264	30.0	0.0	66.2
5-Oct	4	0	0	177	0	0	1	0	0	182	6,974,446	27.4	0.0	65.8
6-Oct	6	2	0	225	0	1	0	0	0	234	6,974,680	29.9	0.0	65.3
7-Oct	25	2	0	432	0	1	9	0	2	471	6,975,151	27.7	0.0	65.3
8-Oct	14	0	0	288	0	3	3	0	0	308	6,975,459	28.6	0.0	65.3
9-Oct	10	1	0	132	0	2	0	0	0	145	6,975,604	27.1	0.0	64.4
10-Oct	10	1	0	86	0	2	0	0	0	99	6,975,703	28.8	0.0	63.5

11-Oct	11	0	0	56	0	1	1	0	0	69	6,975,772	29.2	0.0	62.6
12-Oct	23	0	0	88	1	1	5	0	0	118	6,975,890	28.1	0.0	62.6
13-Oct	57	1	0	73	0	1	2	0	0	134	6,976,024	29.0	0.0	61.7
14-Oct	21	0	0	81	1	1	3	0	0	107	6,976,131	28.1	0.0	61.2
15-Oct	48	2	0	61	0	1	0	0	0	112	6,976,243	29.3	0.0	61.2
16-Oct	38	2	0	28	0	0	1	1	0	70	6,976,313	28.3	0.0	60.1
17-Oct	44	4	0	29	0	0	0	4	0	81	6,976,394	28.5	0.0	59.9
18-Oct	47	2	0	40	0	2	0	1	0	92	6,976,486	27.9	0.0	59.9
19-Oct	56	2	0	35	0	3	0	0	0	96	6,976,582	26.2	0.0	59.0

Table 1. Daily Smolt Collection Counts, River Flows and Temperature at Lower Granite Dam, 1998.

	Daily Smolt Collection Counts											River Conditions		
	Yearling Chinook		Sub-yr Chinook		Steelhead		Coho	Sockeye/Kokanee		Daily	Cumulative	River	Spill	Temp.
Date	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Unk	Hatchery	Wild	Total	Total	(kcfs)	(kcfs)	(F)
20-Oct	43	2	0	30	0	0	0	1	1	77	6,976,659	18.2	0.0	59.0
21-Oct	28	0	0	36	0	2	1	3	0	70	6,976,729	17.3	0.0	58.1
22-Oct	17	0	0	26	0	0	0	0	0	43	6,976,772	18.3	0.0	57.7
23-Oct	29	0	0	31	0	0	1	0	0	61	6,976,833	19.4	0.0	57.4
24-Oct	30	1	0	24	0	1	0	2	0	58	6,976,891	17.4	0.0	57.2
25-Oct	30	0	0	7	0	1	4	0	0	42	6,976,933	16.8	0.0	56.5
26-Oct	16	0	0	13	0	1	3	2	0	35	6,976,968	19.7	0.0	55.8
27-Oct	11	0	0	6	0	0	1	0	0	18	6,976,986	17.4	0.0	55.4
28-Oct	8	3	0	7	0	0	0	0	0	18	6,977,004	18.1	0.0	54.9
29-Oct	9	0	0	4	0	0	1	0	0	14	6,977,018	18.1	0.0	54.5
30-Oct	7	1	0	7	0	2	0	0	0	17	6,977,035	18.0	0.0	54.5
31-Oct	26	2	0	3	0	3	0	2	0	36	6,977,071	18.8	0.0	53.6
1-Nov	80	4	0	39	1	3	15	1	0	143	6,977,214	16.0	0.0	53.6
Total	1,317,503	287,186	520	81,286	4,527,534	557,991	155,546	48,623	1,025	6,977,214				

Table 2. Daily Bypass and Transportation Numbers at Lower Granite Dam, 1998

	Daily Numbers of Fish Bypassed										Daily Numbers of Fish Transported									
	Yearling Chinook		Sub-yr. Chinook		Steelhead		Coho	Sockeye/ kokanee		Daily	Yearling Chinook		Sub-yr. Chinook		Steelhead		Coho	Sockeye/kokanee		Daily
Date	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk.	Hatch	Wild	Total	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk.	Hatch	Wild	Total
27-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Mar	0	0	0	0	0	0	0	0	0	0	126	154	0	10	118	680	10	0	0	1,098
29-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Mar	0	0	0	0	0	0	0	0	0	0	237	203	0	9	157	1,401	13	0	0	2,020
31-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Apr	0	0	0	0	0	0	0	0	0	0	1,078	479	0	10	1,443	3,831	60	0	10	6,911
2-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Apr	0	0	0	0	0	0	0	0	0	0	2,461	2,720	0	0	7,051	4,901	26	0	0	17,159
4-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Apr	3,430	3,835	0	14	4,516	2,171	14	0	0	13,980	4,514	5,197	0	6	10,247	4,360	19	0	0	24,343
6-Apr	619	563	0	0	408	116	0	0	0	1,706	0	0	0	0	0	0	0	0	0	0
7-Apr	2,936	2,864	0	19	5,543	813	0	0	0	12,175	6,553	5,762	0	11	8,923	2,192	0	0	0	23,441
8-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Apr	211	243	0	0	80	21	0	0	0	555	4,942	2,932	0	0	10,968	1,829	20	0	0	20,691
10-Apr	530	263	0	0	84	20	0	0	0	897	0	0	0	0	0	0	0	0	0	0
11-Apr	1,875	536	0	0	83	18	0	0	0	2,512	2,603	2,381	0	20	6,450	1,198	39	0	0	12,691
12-Apr	1,541	415	0	0	80	19	0	0	0	2,055	0	0	0	0	0	0	0	0	0	0
13-Apr	2,032	462	0	0	80	20	0	0	0	2,594	4,240	2,226	0	0	16,103	2,701	20	0	0	25,290
14-Apr	1,211	270	0	0	74	26	0	0	0	1,581	0	0	0	0	0	0	0	0	0	0
15-Apr	3,531	625	0	0	80	20	0	0	0	4,256	18,421	7,199	0	20	16,469	2,728	0	0	0	44,837
16-Apr	1,857	472	0	0	77	23	0	0	0	2,429	0	0	0	0	0	0	0	0	0	0
17-Apr	1,295	207	0	0	79	21	0	0	0	1,602	19,296	8,147	0	0	24,376	2,859	49	0	0	54,727
18-Apr	1,968	299	0	0	74	26	0	0	0	2,367	0	0	0	0	0	0	0	0	0	0
19-Apr	1,349	262	0	0	66	34	0	0	0	1,711	29,343	7,589	0	0	27,064	3,591	0	0	0	67,587
20-Apr	3,772	450	0	0	74	28	0	0	0	4,324	0	0	0	0	0	0	0	0	0	0
21-Apr	1,493	216	0	0	257	148	0	0	0	2,114	55,981	10,856	0	0	34,934	5,430	0	0	0	107,201
22-Apr	1,924	282	0	0	309	94	0	0	0	2,609	0	0	0	0	0	0	0	0	0	0
23-Apr	4,328	647	0	0	298	106	0	0	0	5,379	88,275	15,344	0	0	29,427	6,504	200	0	0	139,750
24-Apr	4,000	516	0	0	272	134	0	0	0	4,922	0	0	0	0	0	0	0	0	0	0
25-Apr	1,819	185	0	0	245	156	0	0	0	2,405	119,765	13,087	0	100	79,047	14,318	700	0	0	227,017
26-Apr	2,877	313	0	0	233	173	0	0	0	3,596	63,982	7,186	0	0	127,164	23,627	300	0	0	222,259
27-Apr	1,282	142	0	0	260	144	0	0	0	1,828	58,699	7,957	0	0	216,785	34,356	300	0	0	318,097
28-Apr	1,211	77	0	0	506	348	0	0	0	2,142	62,231	9,519	0	0	213,470	39,872	0	0	0	325,092
29-Apr	3,123	245	0	0	431	423	0	0	0	4,222	32,971	7,251	0	1,050	154,807	26,426	300	0	0	222,805
30-Apr	1,679	105	0	0	588	263	0	0	0	2,635	45,346	6,633	0	0	137,173	25,558	450	0	0	215,160
1-May	1,529	123	0	0	403	450	0	0	0	2,505	39,385	4,524	0	0	119,140	13,950	1,800	0	0	178,799
2-May	2,354	293	0	0	1,050	228	0	0	0	3,925	61,319	10,070	0	0	198,825	13,142	2,100	0	0	285,456
3-May	857	107	0	0	1,084	193	0	0	0	2,241	65,864	18,940	0	0	352,608	20,207	2,100	0	0	459,719
4-May	0	0	0	0	0	0	0	0	0	0	70,890	14,698	0	0	375,897	25,950	1,950	0	0	489,385
5-May	20,986	2,967	0	0	74,921	8,132	1,411	0	0	108,417	48,993	6,929	0	0	176,388	19,183	3,389	0	0	254,882
6-May	1,253	192	0	0	961	207	0	0	0	2,613	54,842	11,205	0	0	225,230	24,693	3,450	1,650	0	321,070
7-May	2,257	283	0	0	909	254	0	0	0	3,703	41,538	6,308	0	0	219,934	18,216	2,547	1,650	0	290,193
8-May	911	130	0	0	857	312	0	0	0	2,210	24,042	5,398	0	448	187,295	19,143	4,800	1,650	0	242,776
9-May	1,140	111	0	0	945	224	0	0	0	2,420	36,520	7,978	0	150	152,365	14,954	6,900	5,400	0	224,267
10-May	1,365	232	0	0	941	229	0	0	0	2,767	40,054	7,700	0	150	83,778	12,668	4,348	1,197	0	149,895
11-May	0	0	0	0	0	0	0	0	0	0	18,262	4,346	0	0	101,694	14,550	4,950	3,599	150	147,551
12-May	1,059	201	0	0	875	176	0	0	0	2,311	13,500	3,699	0	0	107,918	11,395	4,499	5,099	0	146,110
13-May	168	17	0	0	1,117	222	0	0	0	1,524	16,293	3,726	0	0	60,203	7,422	9,449	4,500	0	101,593
14-May	626	51	0	0	1,116	200	0	0	0	1,993	17,025	3,258	0	0	106,806	12,575	11,399	4,650	300	156,013
15-May	631	77	0	0	995	320	0	0	0	2,023	13,584	2,322	0	0	72,479	8,063	15,000	5,547	450	117,445
16-May	165	48	0	0	965	350	0	0	0	1,528	5,319	1,932	0	0	43,888	6,126	8,700	1,495	0	67,460
17-May	0	0	0	0	0	0	0	0	0	0	3,244	3,433	0	0	77,998	7,350	4,350	1,350	0	97,725
18-May	0	0	0	0	0	0	0	0	0	0	4,500	2,399	0	0	95,698	9,300	4,799	1,650	0	118,346
19-May	73	20	0	0	582	120	0	0	0	795	2,248	758	0	0	75,063	5,314	2,850	0	0	86,233
20-May	36	9	0	0	622	80	0	0	0	747	1,459	887	0	450	33,321	3,215	2,396	598	0	42,326
21-May	287	141	0	0	601	107	0	0	0	1,136	0	0	0	0	0	0	0	0	0	0

22-May	104	29	0	0	498	205	0	0	0	836	3,526	1,583	0	0	60,775	8,228	6,150	1,031	0	81,293
23-May	110	43	0	0	590	112	0	0	0	855	4,229	2,215	0	0	39,467	6,008	7,998	600	0	60,517
24-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. Daily Bypass and Transportation Numbers at Lower Granite Dam, 1998

Daily Transportation Numbers

	Daily Numbers of Fish Bypassed										Daily Numbers of Fish Transported									
	Yearling Chinook		Sub-yr. Chinook		Steelhead		Coho	Sockeye/ kokanee		Daily	Yearling Chinook		Sub-yr. Chinook		Steelhead		Coho	Sockeye/kokanee		Daily
Date	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk.	Hatch	Wild	Total	Hatch	Wild	Wild	Hatch	Wild	Hatch	Wild	Unk.	Hatch	Wild	Total
25-May	0	0	0	0	0	0	0	0	0	0	4,585	6,291	0	0	125,855	21,797	11,880	1,499	0	171,907
26-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27-May	37	39	0	0	463	66	0	0	0	605	2,557	2,199	0	528	50,640	10,128	6,270	1,832	60	74,214
28-May	40	42	0	0	447	78	0	0	0	607	0	0	0	0	0	0	0	0	0	0
29-May	14	36	0	0	456	69	0	0	0	575	669	1,003	29	486	32,465	5,695	2,001	505	20	42,873
30-May	18	19	0	0	435	91	0	0	0	563	0	0	0	0	0	0	0	0	0	0
31-May	8	11	0	0	0	0	0	0	0	19	212	220	0	398	17,176	2,175	1,120	188	0	21,489
1-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Jun	6	7	0	0	187	23	0	0	0	223	220	165	119	390	14,551	1,742	1,381	317	10	18,895
3-Jun	5	4	0	0	180	30	0	0	0	219	0	0	0	0	0	0	0	0	0	0
4-Jun	4	4	0	0	177	33	0	0	0	218	219	135	40	218	9,931	1,290	1,413	198	0	13,444
5-Jun	8	3	0	0	186	24	0	0	0	221	0	0	0	0	0	0	0	0	0	0
6-Jun	12	7	0	0	178	32	0	0	0	229	321	126	40	608	12,964	1,424	1,494	307	0	17,284
7-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Jun	0	0	0	0	0	0	0	0	0	0	159	198	58	334	7,583	1,173	655	228	0	10,388
9-Jun	5	1	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
10-Jun	3	3	0	0	0	0	0	0	0	6	69	150	44	198	3,195	465	323	142	0	4,586
11-Jun	2	9	0	0	3	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0
12-Jun	3	4	0	0	0	0	0	0	0	7	141	134	51	167	2,586	360	385	99	0	3,923
13-Jun	7	12	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0
14-Jun	14	10	0	0	2	0	0	0	0	26	359	307	18	162	10,143	769	425	223	0	12,406
15-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Jun	9	11	0	0	0	0	0	0	0	20	158	313	25	238	5,274	618	361	165	0	7,152
17-Jun	11	16	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0
18-Jun	24	10	0	0	0	0	0	0	0	34	258	396	40	463	5,922	465	512	169	0	8,225
19-Jun	12	10	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0
20-Jun	14	7	0	0	0	0	0	0	0	21	166	312	6	263	2,641	244	112	125	0	3,869
21-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jun	0	0	0	0	0	0	0	0	0	0	576	605	19	721	2,395	195	336	180	0	5,027
23-Jun	67	45	0	0	0	0	0	0	0	112	0	0	0	0	0	0	0	0	0	0
24-Jun	43	75	0	0	0	0	0	0	0	118	405	640	0	481	2,575	108	175	78	0	4,462
25-Jun	23	20	0	0	0	0	0	0	0	43	0	0	0	0	0	0	0	0	0	0
26-Jun	33	28	0	0	0	0	0	0	0	61	540	503	18	1,559	2,798	119	236	133	4	5,910
27-Jun	49	31	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0
28-Jun	0	0	0	0	0	0	0	0	0	0	728	516	0	1,500	3,744	122	138	135	0	6,883
29-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Jun	34	42	0	0	0	0	0	0	0	76	629	800	0	1,314	4,207	124	398	54	0	7,526
1-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Jul	0	0	0	37	0	0	0	0	0	37	434	204	0	1,085	3,013	143	375	80	0	5,334
3-Jul	0	0	0	47	0	0	0	0	0	47	0	0	0	0	0	0	0	0	0	0
4-Jul	0	0	0	42	0	0	0	0	0	42	481	997	0	1,450	1,690	88	246	32	0	4,984
5-Jul	0	0	0	44	0	0	0	0	0	44	0	0	0	0	0	0	0	0	0	0
6-Jul	0	0	0	47	0	0	0	0	0	47	490	678	0	1,930	1,634	51	329	48	0	5,160
7-Jul	0	0	0	41	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0
8-Jul	0	0	0	3	0	0	0	0	0	3	879	1,109	0	6,924	1,271	32	1,259	19	8	11,501
9-Jul	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
10-Jul	0	0	0	89	0	0	1	0	0	90	319	309	0	8,648	852	19	1,345	10	0	11,502
11-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Jul	0	0	0	7	0	0	0	0	0	7	132	30	0	3,793	534	36	507	12	0	5,044
13-Jul	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
14-Jul	0	0	0	0	0	0	0	0	0	0	81	6	0	2,755	269	4	257	12	4	3,388
15-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Jul	0	0	0	0	0	0	0	0	0	0	79	14	0	4,854	283	4	384	24	0	5,642
17-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Jul	0	0	0	0	0	0	0	0	0	0	68	52	0	3,904	155	12	211	4	0	4,406

19-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Jul	0	0	0	0	0	0	0	0	0	0	74	39	0	2,395	176	16	159	4	0	2,863
21-Jul	0	0	0	7	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0
22-Jul	0	0	0	7	0	0	0	0	0	7	86	54	0	2,198	256	28	94	0	0	2,716
23-Jul	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
24-Jul	0	0	0	7	0	0	0	0	0	7	100	59	0	1,822	183	4	50	4	0	2,222

Table 2. Daily Bypass and Transportation Numbers at Lower Granite Dam, 1998

Daily Transportation Numbers

	Daily Numbers of Fish Bypassed										Daily Numbers of Fish Transported									
	Yearling Chinook		Sub-yr. Chinook		Steelhead		Coho	Sockeye/ kokanee		Daily	Yearling Chinook		Sub-yr. Chinook		Steelhead		Coho	Sockeye/kokanee		Daily
Date	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk.	Hatch	Wild	Total	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk.	Hatch	Wild	Total
25-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Jul	0	0	0	0	0	0	0	0	0	0	47	24	0	1,689	142	0	35	8	0	1,945
27-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Jul	0	0	0	0	0	0	0	0	0	0	51	35	0	1,433	67	4	79	4	0	1,673
29-Jul	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
30-Jul	0	0	0	0	0	0	0	0	0	0	90	28	0	1,594	102	4	71	0	0	1,889
31-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Aug	0	0	0	0	0	0	0	0	0	0	131	75	0	1,452	107	12	12	3	0	1,792
2-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Aug	0	0	0	7	0	0	0	0	0	7	46	36	0	730	32	4	4	8	0	860
4-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Aug	0	0	0	7	0	0	0	0	0	7	67	30	0	748	52	0	0	0	0	897
6-Aug	0	0	0	6	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
7-Aug	0	0	0	0	0	0	0	0	0	0	105	8	0	1,620	56	4	4	0	0	1,797
8-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Aug	0	0	0	0	0	0	0	0	0	0	71	20	0	1,370	34	0	11	0	0	1,506
10-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Aug	0	0	0	0	0	0	0	0	0	0	29	24	0	826	11	0	4	0	0	894
12-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Aug	0	0	0	0	0	0	0	0	0	0	22	12	0	1,082	0	8	11	0	0	1,135
14-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Aug	0	0	0	0	0	0	0	0	0	0	28	28	0	1,093	8	4	8	0	0	1,169
16-Aug	0	0	0	7	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0
17-Aug	0	0	0	7	0	0	0	0	0	7	36	16	0	1,049	8	3	0	0	0	1,112
18-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Aug	0	0	0	7	0	0	0	0	0	7	8	23	0	821	0	4	0	0	0	856
20-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Aug	0	0	0	0	0	0	0	0	0	0	12	0	0	561	4	0	0	0	0	577
22-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Aug	0	0	0	0	0	0	0	0	0	0	16	1	0	297	2	0	0	0	1	317
24-Aug	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
25-Aug	0	0	0	0	1	1	0	0	0	2	12	13	0	287	0	0	8	1	0	321
26-Aug	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
27-Aug	0	0	0	0	1	1	0	0	0	2	20	1	0	298	0	0	4	0	0	323
28-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Aug	0	0	0	7	0	0	0	0	0	7	11	1	0	286	0	0	2	0	1	301
30-Aug	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0
31-Aug	0	0	0	7	0	2	0	0	0	9	16	12	0	275	0	0	3	0	1	307
1-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Sep	0	0	0	7	0	0	0	0	0	7	5	3	0	132	0	0	5	0	0	145
3-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Sep	0	0	0	0	0	1	0	0	0	1	5	3	0	60	0	0	8	0	1	77
5-Sep	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
6-Sep	0	0	0	0	0	0	0	0	0	0	1	0	0	52	0	0	2	0	0	55
7-Sep	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
8-Sep	0	0	0	0	0	1	0	0	0	1	11	2	0	117	0	0	2	0	0	132
9-Sep	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
10-Sep	0	0	0	0	0	1	0	0	0	1	15	2	0	224	0	0	4	0	0	245
11-Sep	0	0	0	0	1	0	4	0	0	5	0	0	0	0	0	0	0	0	0	0
12-Sep	0	0	0	0	0	2	5	0	0	7	10	4	0	276	0	0	0	1	0	291
13-Sep	0	0	0	0	1	1	2	0	0	4	0	0	0	0	0	0	0	0	0	0
14-Sep	0	0	0	0	0	0	2	0	0	2	9	5	0	147	0	0	0	0	0	161

15-Sep	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
16-Sep	0	0	0	0	0	0	0	0	0	0	6	2	0	109	0	0	1	0	0	118
17-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Sep	0	0	0	0	0	0	2	0	0	2	3	3	0	91	0	0	2	0	0	99
19-Sep	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
20-Sep	0	0	0	0	1	0	1	0	0	2	11	4	0	187	0	0	0	0	0	202
21-Sep	0	0	0	75	0	1	0	0	0	76	0	0	0	0	0	0	0	0	0	0
22-Sep	0	0	0	0	1	0	0	0	0	1	2	2	0	490	0	0	5	0	0	499
23-Sep	0	0	0	313	0	0	2	0	0	315	0	0	0	0	0	0	0	0	0	0

Table 2. Daily Bypass and Transportation Numbers at Lower Granite Dam, 1998

Daily Transportation Numbers

Daily Numbers of Fish Bypassed

	Yearling Chinook		Sub-yr. Chinook		Steelhead		Coho	Sockeye/ kokanee		Daily
Date	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk.	Hatch	Wild	Total
24-Sep	0	0	0	0	0	1	0	0	0	1
25-Sep	3	0	0	135	0	0	0	0	0	138
26-Sep	0	0	0	0	0	1	1	0	0	2
27-Sep	0	0	0	0	1	1	0	0	0	2
28-Sep	0	0	0	0	1	0	3	0	0	4
29-Sep	0	0	0	0	0	2	1	0	0	3
30-Sep	0	0	0	0	0	1	1	0	0	2
1-Oct	0	0	0	0	1	1	1	0	0	3
2-Oct	0	0	0	0	0	2	2	0	0	4
3-Oct	0	0	0	0	0	3	0	0	0	3
4-Oct	0	0	0	0	0	1	0	0	0	1
5-Oct	0	0	0	0	0	0	0	0	0	0
6-Oct	0	0	0	0	0	1	0	0	0	1
7-Oct	0	0	0	0	0	1	1	0	0	2
8-Oct	0	0	0	0	0	2	0	0	0	2
9-Oct	0	0	0	0	0	2	0	0	0	2
10-Oct	0	0	0	0	0	2	0	0	0	2
11-Oct	0	0	0	0	0	1	1	0	0	2
12-Oct	0	0	0	0	1	1	1	0	0	3
13-Oct	0	0	0	0	0	1	2	0	0	3
14-Oct	0	0	0	0	1	1	0	0	0	2
15-Oct	0	0	0	0	0	1	0	0	0	1
16-Oct	0	0	0	0	0	0	0	0	0	0
17-Oct	0	0	0	0	0	0	0	0	0	0
18-Oct	0	0	0	0	0	1	0	0	0	1
19-Oct	0	0	0	0	0	3	0	0	0	3
20-Oct	0	0	0	0	0	0	0	0	0	0
21-Oct	0	0	0	0	0	2	0	0	0	2
22-Oct	0	0	0	0	0	0	0	0	0	0
23-Oct	0	0	0	0	0	0	0	0	0	0
24-Oct	0	0	0	0	0	1	0	0	0	1
25-Oct	0	0	0	0	0	1	1	0	0	2
26-Oct	0	0	0	0	0	1	0	0	0	1
27-Oct	0	0	0	0	0	0	0	0	0	0
28-Oct	0	0	0	0	0	0	0	0	0	0
29-Oct	0	0	0	0	0	0	1	0	0	1
30-Oct	0	0	0	0	0	2	0	0	0	2
31-Oct	0	0	0	0	0	3	0	0	0	3
1-Nov	0	0	0	0	1	2	14	0	0	17
Totals	88,312	20,074	0	1,003	107,561	17,990	1,474	0	0	236,414

Daily Numbers of Fish Transported

	Yearling Chinook		Sub-yr. Chinook		Steelhead		Coho	Sockeye/kokanee		Daily
	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk.	Hatch	Wild	Total
	7	6	0	486	0	0	0	0	0	499
	0	0	0	0	0	0	0	0	0	0
	4	0	0	490	0	0	0	0	0	494
	0	0	0	0	0	0	0	0	0	0
	8	1	0	379	0	0	1	0	0	389
	0	0	0	0	0	0	0	0	0	0
	7	0	0	543	0	0	0	0	0	550
	0	0	0	0	0	0	0	0	0	0
	3	3	0	489	0	0	0	0	0	495
	0	0	0	0	0	0	0	0	0	0
	7	0	0	435	0	0	0	0	0	442
	0	0	0	0	0	0	0	0	0	0
	10	2	0	335	0	0	1	0	0	348
	0	0	0	0	0	0	0	0	0	0
	39	2	0	676	0	0	11	0	1	729
	0	0	0	0	0	0	0	0	0	0
	19	2	0	166	0	0	0	0	0	187
	0	0	0	0	0	0	0	0	0	0
	34	0	0	136	0	0	3	0	0	173
	0	0	0	0	0	0	0	0	0	0
	78	1	0	144	0	0	3	0	0	226
	0	0	0	0	0	0	0	0	0	0
	86	4	0	78	0	0	1	1	0	170
	0	0	0	0	0	0	0	0	0	0
	91	6	0	67	0	0	0	5	0	169
	0	0	0	0	0	0	0	0	0	0
	98	4	0	63	0	0	0	1	1	167
	0	0	0	0	0	0	0	0	0	0
	45	0	0	59	0	0	1	3	0	108
	0	0	0	0	0	0	0	0	0	0
	57	1	0	55	0	0	1	2	0	116
	0	0	0	0	0	0	0	0	0	0
	46	0	0	20	0	0	5	2	0	73
	0	0	0	0	0	0	0	0	0	0
	19	3	0	13	0	0	1	0	0	36
	0	0	0	0	0	0	0	0	0	0
	16	1	0	11	0	0	0	0	0	28
	0	0	0	0	0	0	0	0	0	0
	105	6	0	42	0	1	1	3	0	158
Totals	1,225,569	266,153	507	78,303	4,416,532	539,512	153,575	48,534	1,022	6,729,707

Table 3. Daily Facility Mortality and Percent Descaling at Lower Granite Dam, 1998

	Daily Facility (raceway and sample) Mortality											Daily Percent Descaling									
	Yearling Chin.		Sub-yr Chin.		Steelhead		Coho	Sockeye/Kokanee		Daily	%	Yearling Chin.		Sub-yr Chin.		Steelhead		Coho	Sockeye/Kokanee		Daily
Date	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk	Hatch	Wild	Total	Mort	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk	Hatch	Wild	Total
27-Mar	2	2	0	0	2	1	0	0	0	7	3.89	0.0	25.0	---	---	---	0.0	0.0	---	---	7.7
28-Mar	2	4	0	0	0	9	0	0	0	15	1.60	0.0	8.3	---	0.0	0.0	0.0	---	---	---	1.1
29-Mar	2	4	0	1	2	10	6	0	0	25	2.81	0.0	0.0	---	---	0.0	1.4	0.0	---	---	1.2
30-Mar	1	3	0	0	1	9	1	0	0	15	1.28	0.0	0.0	---	---	0.0	1.4	0.0	---	---	0.9
31-Mar	7	5	0	0	6	13	0	0	0	31	0.99	2.9	0.0	---	0.0	2.0	1.0	---	---	---	1.3
1-Apr	15	6	0	0	11	26	0	0	0	58	1.50	5.6	0.0	---	---	2.1	0.5	0.0	---	0.0	1.8
2-Apr	5	4	0	0	0	3	1	0	0	13	0.29	0.0	0.0	---	---	2.3	2.0	0.0	---	---	1.6
3-Apr	4	6	0	0	9	6	3	0	0	28	0.22	1.6	0.5	---	---	0.6	0.3	0.0	---	---	0.6
4-Apr	17	17	0	0	12	5	1	0	0	52	0.27	0.4	0.8	---	---	1.0	1.2	0.0	---	---	0.9
5-Apr	5	12	0	0	2	0	0	0	0	19	0.10	1.3	0.8	---	0.0	1.0	1.3	0.0	---	---	1.0
6-Apr	16	23	0	0	2	3	0	0	0	44	0.18	1.1	0.8	---	0.0	0.8	0.9	---	---	---	0.9
7-Apr	0	4	0	0	0	0	0	0	0	4	0.03	0.0	1.4	---	0.0	0.7	2.4	---	---	---	0.8
8-Apr	6	3	0	0	1	0	0	0	0	10	0.09	0.6	1.1	---	---	0.0	0.0	---	---	---	0.3
9-Apr	5	2	0	0	0	1	0	0	0	8	0.08	3.1	3.2	---	---	0.4	0.0	0.0	---	---	1.3
10-Apr	8	1	0	0	0	1	0	0	0	10	0.12	0.0	2.5	---	0.0	1.7	2.5	0.0	---	---	1.4
11-Apr	20	3	0	0	6	0	1	0	0	30	0.39	0.8	1.3	---	---	0.0	4.8	---	---	---	0.8
12-Apr	36	27	0	0	7	0	0	0	0	70	0.76	0.0	1.4	---	---	0.0	0.0	---	---	---	0.2
13-Apr	31	10	0	0	10	0	0	0	0	51	0.25	0.9	0.0	---	---	0.6	0.0	0.0	---	---	0.6
14-Apr	22	6	0	0	13	1	0	0	0	42	0.27	1.3	1.0	---	0.0	1.1	0.0	---	---	---	1.1
15-Apr	115	80	0	0	9	0	0	0	0	204	0.57	0.4	0.0	---	---	0.9	0.0	---	---	---	0.5
16-Apr	132	37	0	0	12	1	1	0	0	183	0.66	4.1	0.0	---	---	1.4	0.0	0.0	---	---	2.2
17-Apr	53	4	0	0	1	1	0	0	0	59	0.19	1.8	1.1	---	---	2.2	2.9	---	---	---	1.9
18-Apr	58	7	0	0	11	2	0	0	0	78	0.22	1.7	2.7	---	---	3.0	2.2	---	---	---	2.5
19-Apr	64	11	0	0	23	2	0	0	0	100	0.27	1.7	1.1	---	---	2.0	0.0	---	---	---	1.6
20-Apr	49	3	0	0	13	1	0	0	0	66	0.18	0.8	3.0	---	---	4.8	0.0	---	---	---	2.4
21-Apr	141	39	0	0	14	1	0	0	0	195	0.25	0.7	0.0	---	---	4.0	2.5	---	---	---	1.7
22-Apr	102	33	0	0	22	1	0	0	0	158	0.21	1.9	1.3	---	---	3.8	1.7	50.0	---	---	2.3
23-Apr	514	101	0	0	33	6	0	0	0	654	0.91	2.7	0.0	---	---	1.6	0.0	0.0	---	---	2.0
24-Apr	124	11	0	0	10	0	0	0	0	145	0.15	2.9	1.7	---	0.0	4.8	2.8	0.0	---	---	3.4
25-Apr	182	11	0	0	13	5	0	0	0	211	0.15	2.0	0.0	---	---	3.8	2.7	0.0	---	---	2.6
26-Apr	41	1	0	0	3	0	0	0	0	45	0.02	2.1	1.3	---	---	3.1	0.4	0.0	---	---	2.5
27-Apr	19	1	0	0	5	0	0	0	0	25	0.01	4.8	1.9	---	---	3.5	1.7	0.0	---	---	3.5
28-Apr	78	15	0	0	4	0	0	0	0	97	0.03	2.9	0.0	---	---	3.4	0.7	---	---	---	2.9
29-Apr	56	4	0	0	12	1	0	0	0	73	0.03	3.0	0.0	---	0.0	3.0	2.8	0.0	---	---	2.9
30-Apr	72	19	0	0	15	3	0	0	0	109	0.05	1.4	0.0	---	---	0.8	2.3	0.0	---	---	1.1
1-May	36	3	0	0	7	0	0	0	0	46	0.03	2.9	0.0	---	---	3.9	2.1	0.0	---	---	3.4
2-May	14	0	0	0	5	0	0	0	0	19	0.01	1.7	1.4	---	---	3.2	4.5	7.1	---	---	2.9
3-May	29	3	0	0	8	0	0	0	0	40	0.01	6.1	3.2	---	---	1.8	0.0	0.0	---	---	2.4
4-May	44	2	0	0	3	0	0	0	0	49	0.01	9.3	7.3	---	---	3.1	2.3	0.0	---	---	4.1
5-May	143	13	0	0	24	2	0	0	0	182	0.05	5.0	0.0	---	---	7.1	1.1	0.0	---	---	5.9
6-May	33	3	0	0	9	0	0	0	0	45	0.01	4.4	1.4	---	---	5.2	1.8	4.3	0.0	---	4.6
7-May	98	16	0	0	34	3	3	0	0	154	0.05	7.1	2.4	---	---	5.2	0.8	5.9	0.0	---	5.2
8-May	117	22	0	2	398	45	0	0	0	584	0.24	4.8	0.0	---	0.0	3.6	3.8	0.0	9.1	---	3.6
9-May	66	9	0	0	59	3	0	0	0	137	0.06	4.0	5.8	---	0.0	7.5	1.0	2.2	5.6	---	6.2
10-May	120	18	0	0	31	3	2	3	0	177	0.12	4.4	3.8	---	0.0	4.1	2.3	0.0	12.5	---	3.9
11-May	38	4	0	0	6	0	0	1	0	49	0.03	5.0	3.6	---	---	6.1	2.1	6.1	8.3	0.0	5.5
12-May	27	5	0	0	4	1	1	1	0	39	0.03	6.3	7.7	---	---	10.1	1.3	0.0	0.0	---	8.3
13-May	39	7	0	0	30	6	1	0	0	83	0.08	4.6	8.3	---	---	5.9	6.0	0.0	3.3	---	5.1
14-May	13	2	0	0	2	1	1	0	0	19	0.01	6.9	4.8	---	---	8.8	1.2	3.9	3.2	0.0	7.3
15-May	8	1	0	0	10	3	0	3	0	25	0.02	7.4	0.0	---	---	7.4	5.4	7.0	2.7	0.0	6.8
16-May	6	1	0	0	66	5	0	4	0	82	0.12	8.3	0.0	---	---	7.7	2.3	6.9	10.0	---	7.0
17-May	3	1	0	0	2	0	0	0	0	6	0.01	4.5	0.0	---	---	8.7	2.0	0.0	0.0	---	7.2
18-May	0	1	0	0	2	0	1	0	0	4	0.00	6.7	0.0	---	---	7.4	0.0	3.1	9.1	---	6.5
19-May	1	0	0	0	20	1	0	0	0	22	0.03	6.7	0.0	---	---	3.6	2.8	15.8	---	---	4.0
20-May	5	4	0	0	107	5	4	2	0	127	0.29	0.0	0.0	---	0.0	3.5	0.0	6.3	0.0	---	3.1

21-May	12	11	0	0	51	5	9	2	0	90	0.25	0.0	0.0	---	---	3.7	0.0	0.0	0.0	---	3.0
22-May	103	42	0	0	760	120	141	17	0	1183	2.43	0.0	0.0	---	---	4.1	0.0	0.0	0.0	---	2.9
23-May	7	3	0	0	23	0	2	0	0	35	0.06	11.6	0.0	---	---	2.8	3.3	7.7	0.0	---	3.9
24-May	10	8	0	0	18	1	12	0	0	49	0.07	9.5	0.0	---	---	5.9	1.0	7.9	---	---	5.2

Table 3. Daily Facility Mortality and Percent Descaling at Lower Granite Dam, 1998

	Daily Facility (raceway and sample) Mortality											Daily Percent Descaling									
	Yearling Chin.		Sub-yr Chin.		Steelhead		Coho	Sockeye/Kokanee		Daily	%	Yearling Chin.		Sub-yr Chin.		Steelhead		Coho	Sockeye/Kokanee		Daily
Date	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk	Hatch	Wild	Total	Mort	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk	Hatch	Wild	Total
25-May	5	1	0	0	27	2	8	1	0	44	0.04	0.0	0.0	---	---	4.7	0.8	5.7	0.0	---	4.0
26-May	9	8	0	0	14	3	8	2	0	44	0.09	9.2	0.0	---	0.0	6.4	1.9	7.0	1.7	0.0	5.6
27-May	22	24	0	2	34	2	12	6	0	102	0.36	8.9	6.7	---	0.0	12.1	2.7	4.6	1.7	---	9.4
28-May	10	10	0	3	31	5	16	5	0	80	0.28	7.0	1.4	---	2.9	11.3	1.6	6.5	7.7	0.0	9.3
29-May	2	2	1	1	4	0	3	0	0	13	0.08	8.0	6.5	33.3	0.0	12.0	1.0	2.6	9.1	0.0	9.8
30-May	3	2	0	0	15	0	9	0	0	29	0.27	10.5	4.3	---	6.3	7.1	4.6	10.9	9.1	---	7.0
31-May	4	2	0	2	38	0	11	2	0	59	0.52	0.0	0.0	---	0.0	11.1	2.1	13.0	0.0	---	10.1
1-Jun	4	6	0	0	39	6	5	2	0	62	0.61	8.3	0.0	16.7	0.0	8.2	8.0	7.6	0.0	---	7.8
2-Jun	1	5	1	0	36	6	4	1	0	54	0.60	27.3	16.7	0.0	0.0	7.1	4.1	0.0	0.0	0.0	6.3
3-Jun	0	4	0	1	32	3	3	1	0	44	0.68	0.0	0.0	50.0	0.0	9.0	4.7	7.9	0.0	---	8.2
4-Jun	2	3	0	1	39	5	4	1	0	55	0.74	6.7	14.3	0.0	7.1	8.6	2.9	3.9	0.0	---	7.4
5-Jun	6	3	0	2	46	6	5	2	0	70	0.67	0.0	12.5	0.0	0.0	7.7	1.2	2.0	0.0	---	6.2
6-Jun	3	1	0	0	25	5	1	1	0	36	0.49	0.0	0.0	33.3	2.4	6.9	4.9	3.9	0.0	---	6.1
7-Jun	0	1	1	0	15	5	0	2	0	24	0.41	0.0	0.0	0.0	0.0	5.7	9.3	6.1	6.3	---	5.6
8-Jun	1	1	1	6	12	2	5	0	0	28	0.60	0.0	28.6	33.3	0.0	6.9	4.8	0.0	0.0	---	6.6
9-Jun	2	0	0	3	36	0	7	0	0	48	1.88	0.0	11.1	0.0	9.1	10.5	11.1	12.5	0.0	---	9.7
10-Jun	9	12	0	13	55	15	14	8	0	126	5.70	0.0	6.7	0.0	0.0	11.3	12.2	14.0	10.0	---	10.9
11-Jun	2	1	0	5	32	1	5	0	0	46	3.55	0.0	9.1	0.0	12.5	15.5	0.0	13.8	0.0	---	13.0
12-Jun	17	27	4	3	142	11	10	1	0	215	7.39	9.1	4.8	10.0	0.0	11.4	7.1	11.4	0.0	---	9.8
13-Jun	7	2	1	1	198	17	10	2	0	238	2.49	0.0	2.4	---	0.0	1.4	12.1	6.5	0.0	---	2.1
14-Jun	8	4	1	2	71	10	5	0	0	101	3.12	0.0	0.0	0.0	0.0	5.8	7.4	10.8	0.0	---	5.5
15-Jun	1	0	0	0	7	0	3	0	0	11	0.26	20.0	3.6	20.0	3.3	4.3	6.0	9.7	7.1	---	5.0
16-Jun	2	1	0	2	8	3	1	0	0	17	0.57	0.0	5.6	---	5.6	8.9	15.0	7.7	0.0	---	8.3
17-Jun	0	2	0	1	9	0	3	2	0	17	0.35	12.0	14.6	0.0	2.0	4.6	3.4	6.5	0.0	---	5.1
18-Jun	0	0	0	1	5	1	4	1	0	12	0.34	7.1	3.4	---	2.9	5.8	7.4	17.6	6.3	---	6.4
19-Jun	0	0	0	0	2	0	0	1	0	3	0.13	6.7	3.8	---	0.0	7.3	4.2	0.0	0.0	---	6.1
20-Jun	0	1	0	1	3	0	2	0	0	7	0.43	0.0	3.6	0.0	21.1	7.4	0.0	0.0	0.0	---	6.3
21-Jun	0	2	0	0	0	0	0	0	0	2	0.09	7.7	4.2	0.0	0.0	6.2	0.0	14.0	0.0	---	5.4
22-Jun	0	1	1	3	1	1	0	0	0	7	0.24	3.8	5.0	0.0	0.0	5.2	3.4	4.9	9.1	---	4.2
23-Jun	0	0	0	1	6	1	1	0	0	9	0.30	6.0	2.6	---	4.5	4.0	0.0	8.7	0.0	---	4.0
24-Jun	9	8	0	2	15	5	0	2	0	41	2.30	7.1	0.0	---	6.1	5.6	0.0	5.0	20.0	---	5.3
25-Jun	34	18	2	39	170	6	20	5	0	294	9.67	9.4	7.7	0.0	4.0	6.2	8.3	4.8	0.0	---	5.8
26-Jun	26	15	0	34	124	3	8	2	0	212	6.09	7.1	2.7	---	1.9	7.7	0.0	5.9	0.0	0.0	5.3
27-Jun	1	1	0	5	9	0	0	1	0	17	0.65	1.5	2.2	---	5.2	5.5	0.0	0.0	0.0	---	4.5
28-Jun	8	2	0	9	20	2	0	2	0	43	0.97	4.9	4.9	---	2.5	5.0	12.5	5.9	0.0	---	4.4
29-Jun	5	5	0	14	11	1	1	0	0	37	0.91	3.3	4.9	---	5.1	3.8	0.0	2.6	0.0	---	3.9
30-Jun	16	5	0	10	11	4	3	0	0	49	1.35	8.0	2.9	---	8.8	5.0	0.0	3.6	0.0	---	5.9
1-Jul	4	0	0	6	7	1	0	0	0	18	0.69	0.0	8.3	---	8.2	5.4	0.0	0.0	37.5	---	5.6
2-Jul	2	0	0	10	16	0	1	0	0	29	1.03	5.4	9.1	---	5.7	5.5	0.0	4.2	0.0	---	5.4
3-Jul	1	1	0	6	3	0	0	0	0	11	0.40	6.3	7.9	---	2.7	4.2	7.7	2.7	0.0	---	4.9
4-Jul	2	2	0	13	3	0	2	0	0	22	0.93	1.8	1.0	---	3.5	7.5	11.1	8.0	0.0	---	4.3
5-Jul	1	0	0	12	1	0	1	0	0	15	0.52	2.9	2.8	---	3.6	4.6	0.0	9.1	0.0	---	3.9
6-Jul	1	2	0	15	5	1	6	0	0	30	1.25	3.8	4.7	---	2.2	6.8	0.0	6.3	12.5	---	4.6
7-Jul	0	0	0	4	0	0	0	0	0	4	0.15	3.5	0.0	---	3.3	7.9	0.0	1.4	0.0	---	3.7
8-Jul	1	3	0	35	5	0	13	1	0	58	0.64	3.1	1.7	---	1.0	1.0	0.0	1.6	0.0	50.0	1.3
9-Jul	0	0	0	12	3	0	2	0	0	17	0.22	0.0	0.0	---	0.3	14.0	0.0	1.5	0.0	---	1.2
10-Jul	1	1	0	38	5	1	12	0	0	58	1.53	12.5	0.0	---	2.0	2.6	---	0.0	---	---	1.9
11-Jul	1	0	0	18	2	0	4	0	0	25	0.98	8.3	33.3	---	1.0	10.3	25.0	0.0	0.0	---	2.4
12-Jul	5	0	0	106	10	0	29	0	0	150	5.61	0.0	0.0	---	1.8	5.8	0.0	0.0	---	---	2.1
13-Jul	1	2	0	19	1	0	3	0	0	26	2.45	0.0	50.0	---	1.1	11.1	0.0	3.8	0.0	0.0	2.8
14-Jul	6	4	0	45	6	0	8	0	0	69	2.85	0.0	0.0	---	2.0	4.9	---	2.6	0.0	---	2.2
15-Jul	0	0	0	19	1	0	0	0	0	20	0.68	0.0	0.0	---	0.6	0.0	---	5.1	0.0	---	0.8
16-Jul	1	2	0	35	4	0	4	0	0	46	1.67	0.0	0.0	---	1.2	5.4	0.0	1.7	0.0	---	1.5

17-Jul	0	1	0	13	2	0	1	0	0	17	0.66	0.0	0.0	---	1.1	0.0	0.0	0.0	0.0	---	0.9
18-Jul	0	3	0	15	3	0	4	0	0	25	1.32	20.0	0.0	---	1.7	0.0	0.0	0.0	---	---	1.7
19-Jul	0	1	0	20	1	0	1	0	0	23	1.55	0.0	0.0	---	1.0	0.0	0.0	0.0	0.0	---	0.8
20-Jul	2	0	0	21	3	0	0	0	0	26	1.82	0.0	0.0	---	1.3	4.2	0.0	0.0	---	---	1.4
21-Jul	1	0	0	10	4	0	2	0	0	17	1.26	0.0	0.0	---	1.5	11.1	0.0	9.1	---	---	2.4
22-Jul	1	2	0	18	4	0	0	0	0	25	1.76	0.0	0.0	---	3.8	5.4	0.0	0.0	---	---	3.7
23-Jul	3	1	0	12	0	0	0	0	0	16	1.25	0.0	0.0	---	2.3	7.7	---	0.0	0.0	---	2.5

Table 3. Daily Facility Mortality and Percent Descaling at Lower Granite Dam, 1998

Daily Facility (raceway and sample) Mortality

	Yearling Chin.		Sub-yr Chin.		Steelhead		Coho	Sockeye/Kokanee		Daily	%
Date	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk	Hatch	Wild	Total	Mort
24-Jul	1	0	0	34	5	0	2	0	0	42	4.17
25-Jul	0	0	0	5	0	0	0	0	0	5	0.49
26-Jul	1	0	0	30	2	0	1	0	0	34	3.50
27-Jul	0	0	0	8	1	0	0	0	0	9	0.80
28-Jul	5	1	0	35	0	0	1	0	0	42	7.00
29-Jul	1	0	0	9	2	0	1	0	0	13	1.20
30-Jul	1	0	0	8	0	0	0	0	0	9	1.09
31-Jul	1	0	0	10	0	0	0	1	0	12	1.35
1-Aug	0	1	0	6	1	0	0	0	0	8	0.87
2-Aug	1	0	0	5	0	0	0	0	0	6	1.06
3-Aug	1	0	0	6	0	0	0	0	0	7	2.24
4-Aug	0	1	0	8	0	0	0	0	0	9	2.16
5-Aug	1	1	0	9	0	0	0	0	0	11	2.17
6-Aug	2	0	0	9	0	0	0	0	0	11	1.61
7-Aug	1	0	0	20	0	0	0	0	0	21	1.82
8-Aug	0	0	0	7	1	0	1	0	0	9	0.92
9-Aug	1	0	0	19	1	0	0	0	0	21	3.78
10-Aug	0	0	0	12	1	0	0	0	0	13	2.75
11-Aug	3	0	0	18	0	0	0	0	0	21	4.61
12-Aug	0	0	0	8	0	0	0	0	0	8	1.18
13-Aug	2	0	0	10	0	0	1	0	0	13	2.73
14-Aug	1	1	0	11	0	0	0	0	0	13	2.39
15-Aug	3	3	0	24	0	0	0	0	0	30	4.49
16-Aug	0	0	0	4	0	1	0	0	0	5	0.75
17-Aug	0	0	0	25	0	0	0	0	0	25	5.08
18-Aug	0	0	0	3	0	0	0	0	0	3	0.64
19-Aug	0	1	0	13	0	0	0	0	0	14	3.43
20-Aug	0	0	0	3	0	0	0	0	0	3	0.81
21-Aug	0	0	0	100	0	0	0	0	0	100	32.47
22-Aug	0	0	0	1	0	0	0	0	0	1	0.55
23-Aug	0	0	0	11	0	0	0	0	0	11	7.53
24-Aug	0	0	0	1	0	0	0	0	0	1	0.56
25-Aug	0	0	0	3	0	0	0	0	0	3	2.00
26-Aug	1	0	0	1	0	0	0	0	0	2	1.32
27-Aug	0	0	0	1	0	0	0	0	0	1	0.56
28-Aug	0	0	0	3	1	0	0	0	0	4	2.33
29-Aug	0	1	0	2	0	0	0	0	1	4	2.78
30-Aug	0	0	0	5	0	0	1	0	0	6	4.00
31-Aug	0	0	0	2	0	0	0	0	0	2	1.13
1-Sep	0	0	0	5	0	0	0	0	0	5	5.38
2-Sep	0	1	0	3	0	0	0	0	0	4	5.88
3-Sep	0	0	0	5	0	0	0	0	0	5	11.11
4-Sep	0	0	0	2	0	0	0	0	0	2	5.00
5-Sep	1	0	0	0	0	0	0	0	0	1	2.78
6-Sep	0	0	0	4	0	0	0	0	0	4	16.00
7-Sep	1	0	0	1	0	0	0	0	0	2	3.64
8-Sep	0	0	0	5	0	0	0	0	0	5	5.81
9-Sep	1	0	0	10	0	0	0	0	0	11	7.59
10-Sep	0	0	0	5	0	0	1	0	0	6	5.04
11-Sep	1	0	0	17	0	0	0	0	0	18	9.68

Daily Percent Descaling

	Yearling Chin.		Sub-yr Chin.		Steelhead		Coho	Sockeye/Kokanee		Daily
Date	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk	Hatch	Wild	Total
24-Jul	12.5	0.0	---	0.5	30.0	0.0	0.0	---	---	3.3
25-Jul	0.0	0.0	---	0.5	5.0	---	0.0	---	---	0.8
26-Jul	20.0	0.0	---	1.0	18.8	---	16.7	0.0	---	3.0
27-Jul	0.0	0.0	---	0.4	28.6	0.0	14.3	0.0	---	1.4
28-Jul	16.7	0.0	---	0.0	0.0	---	0.0	---	---	0.7
29-Jul	0.0	0.0	---	0.9	9.1	---	0.0	---	---	1.1
30-Jul	0.0	0.0	---	1.2	7.1	0.0	12.5	---	---	2.0
31-Jul	0.0	0.0	---	1.8	0.0	---	0.0	---	---	1.4
1-Aug	0.0	0.0	---	1.0	0.0	0.0	0.0	---	---	0.9
2-Aug	0.0	25.0	---	2.6	33.3	0.0	0.0	0.0	---	4.3
3-Aug	0.0	0.0	---	3.0	0.0	---	---	---	---	2.6
4-Aug	0.0	0.0	---	2.6	0.0	---	---	---	---	2.1
5-Aug	0.0	0.0	---	2.8	37.5	---	---	---	---	4.8
6-Aug	0.0	0.0	---	3.5	11.1	---	0.0	---	---	3.6
7-Aug	0.0	0.0	---	1.9	20.0	100	---	---	---	2.5
8-Aug	8.3	0.0	---	1.4	0.0	---	0.0	---	---	1.7
9-Aug	0.0	33.3	---	0.8	0.0	---	0.0	---	---	1.5
10-Aug	0.0	0.0	---	2.9	0.0	---	---	---	---	2.7
11-Aug	0.0	0.0	---	0.9	0.0	---	0.0	---	---	0.9
12-Aug	0.0	0.0	---	1.3	---	0.0	0.0	---	---	1.2
13-Aug	0.0	0.0	---	1.8	---	---	0.0	---	---	1.7
14-Aug	0.0	0.0	---	3.3	0.0	0.0	0.0	---	---	3.1
15-Aug	0.0	16.7	---	0.0	0.0	---	---	---	---	0.6
16-Aug	0.0	0.0	---	0.0	---	0.0	---	---	---	0.0
17-Aug	0.0	---	---	3.6	0.0	---	---	---	---	3.4
18-Aug	0.0	0.0	---	0.9	---	---	---	---	---	0.9
19-Aug	100	0.0	---	2.1	---	0.0	---	---	---	3.0
20-Aug	---	---	---	4.4	---	---	---	---	---	4.4
21-Aug	0.0	---	---	10.1	0.0	---	---	---	---	9.6
22-Aug	14.3	---	---	5.2	0.0	---	---	---	---	5.5
23-Aug	0.0	100	---	4.0	0.0	---	---	---	0.0	4.4
24-Aug	0.0	20.0	---	3.8	0.0	---	0.0	0.0	---	3.9
25-Aug	0.0	0.0	---	6.3	0.0	0.0	0.0	---	---	5.4
26-Aug	8.3	---	---	2.9	---	---	0.0	---	---	3.3
27-Aug	0.0	0.0	---	3.1	0.0	0.0	0.0	---	---	2.8
28-Aug	0.0	---	---	2.5	---	---	0.0	---	0.0	2.4
29-Aug	0.0	0.0	---	3.1	---	---	0.0	---	---	2.9
30-Aug	9.1	33.3	---	0.8	---	0.0	0.0	---	---	2.1
31-Aug	0.0	11.1	---	1.3	---	0.0	0.0	---	0.0	1.7
1-Sep	0.0	---	---	9.8	---	---	0.0	---	---	9.1
2-Sep	0.0	0.0	---	3.5	---	---	0.0	---	---	3.1
3-Sep	0.0	0.0	---	6.3	---	---	0.0	---	---	5.0
4-Sep	0.0	0.0	---	7.1	---	0.0	0.0	---	0.0	5.3
5-Sep	0.0	---	---	6.3	0.0	---	0.0	---	---	5.7
6-Sep	---	---	---	10.0	---	---	0.0	---	---	9.5
7-Sep	16.7	0.0	---	13.3	0.0	---	---	---	---	13.2
8-Sep	0.0	0.0	---	9.7	---	0.0	50.0	---	---	9.9
9-Sep	0.0	0.0	---	5.8	---	0.0	0.0	---	---	5.2
10-Sep	0.0	---	---	6.8	---	0.0	0.0	---	---	6.2
11-Sep	0.0	0.0	---	4.5	0.0	---	0.0	---	---	4.2

12-Sep	0	0	0	9	0	0	1	0	0	10	6.90	0.0	0.0	---	5.0	---	0.0	0.0	0.0	---	4.4
13-Sep	2	0	0	13	0	0	0	0	0	15	12.71	0.0	0.0	---	4.4	0.0	0.0	0.0	---	---	3.9
14-Sep	0	0	0	3	0	0	3	0	0	6	8.57	33.3	0.0	---	3.5	---	---	0.0	---	---	4.7
15-Sep	0	0	0	13	0	0	1	0	0	14	19.72	0.0	50.0	---	9.6	---	0.0	---	---	---	10.5
16-Sep	0	0	0	4	0	0	0	0	0	4	6.06	0.0	---	---	3.5	---	---	0.0	---	---	3.2
17-Sep	0	0	0	8	1	0	0	0	0	9	20.00	0.0	---	---	9.4	---	---	50.0	---	---	11.1
18-Sep	0	0	0	3	0	0	0	0	0	3	4.41	0.0	0.0	---	8.5	---	---	0.0	---	---	7.7
19-Sep	0	0	0	7	0	0	2	0	1	10	9.62	0.0	0.0	---	8.4	0.0	---	---	---	---	7.4
20-Sep	0	0	0	2	0	0	0	0	0	2	1.75	0.0	0.0	---	8.7	0.0	---	0.0	---	---	8.0
21-Sep	0	0	0	6	0	0	0	0	0	6	2.70	0.0	---	---	1.9	---	0.0	0.0	---	---	1.9

Table 3. Daily Facility Mortality and Percent Descaling at Lower Granite Dam, 1998

	Daily Facility (raceway and sample) Mortality											Daily Percent Descaling									
	Yearling Chin.		Sub-yr Chin.		Steelhead		Coho	Sockeye/Kokanee		Daily	%	Yearling Chin.		Sub-yr Chin.		Steelhead		Coho	Sockeye/Kokanee		Daily
Date	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk	Hatch	Wild	Total	Mort	Hatch	Wild	Hatch	Wild	Hatch	Wild	Unk	Hatch	Wild	Total
22-Sep	1	0	0	3	0	1	0	0	0	5	1.37	0.0	0.0	---	6.2	0.0	---	0.0	---	---	6.1
23-Sep	0	0	0	21	0	0	0	0	0	21	4.78	0.0	0.0	---	1.7	---	---	0.0	---	---	1.7
24-Sep	0	0	0	11	0	0	0	0	0	11	2.70	0.0	0.0	---	4.6	---	0.0	---	---	---	4.5
25-Sep	0	0	0	51	0	0	0	0	0	51	14.17	20.0	---	---	5.8	---	---	---	---	---	6.1
26-Sep	1	0	0	22	0	0	1	0	0	24	6.88	0.0	---	---	6.2	---	0.0	0.0	---	---	6.2
27-Sep	1	0	0	41	0	0	0	0	0	42	19.53	33.3	0.0	---	5.8	0.0	100	---	---	---	6.8
28-Sep	2	0	0	10	0	1	0	0	0	13	5.53	0.0	---	---	9.0	0.0	---	0.0	---	---	8.6
29-Sep	0	0	0	47	0	0	2	0	0	49	16.28	0.0	---	---	10.1	---	0.0	100	---	---	10.3
30-Sep	0	0	0	19	0	0	0	0	0	19	5.90	33.3	---	---	14.6	---	0.0	0.0	---	---	14.9
1-Oct	1	0	0	86	0	2	0	0	0	89	29.37	100	100	---	11.0	0.0	0.0	0.0	---	---	11.7
2-Oct	2	0	0	41	0	1	0	0	0	44	13.25	0.0	50.0	---	20.0	---	0.0	0.0	---	---	19.8
3-Oct	0	0	0	92	0	0	1	0	0	93	27.35	50.0	---	---	13.3	---	0.0	---	---	---	13.8
4-Oct	0	0	0	42	0	1	0	0	0	43	17.77	33.3	---	---	28.2	---	0.0	---	---	---	28.1
5-Oct	0	0	0	55	0	0	0	0	0	55	30.22	0.0	---	---	18.9	---	---	0.0	---	---	18.1
6-Oct	0	0	0	12	0	0	0	0	0	12	5.13	0.0	0.0	---	16.4	---	0.0	---	---	---	15.8
7-Oct	0	0	0	27	0	0	0	0	1	28	5.94	8.0	0.0	---	9.1	---	0.0	0.0	---	0.0	8.8
8-Oct	0	0	0	17	0	1	0	0	0	18	5.84	7.1	---	---	21.4	---	0.0	33.3	---	---	20.7
9-Oct	0	0	0	45	0	0	0	0	0	45	31.03	10.0	0.0	---	22.2	---	0.0	---	---	---	20.4
10-Oct	1	0	0	7	0	0	0	0	0	8	8.08	0.0	0.0	---	22.8	---	0.0	---	---	---	19.8
11-Oct	0	0	0	4	0	0	0	0	0	4	5.80	0.0	---	---	28.8	---	0.0	0.0	---	---	23.1
12-Oct	0	0	0	4	0	0	1	0	0	5	4.24	26.1	---	---	17.9	0.0	0.0	25.0	---	---	19.5
13-Oct	0	0	0	7	0	0	0	0	0	7	5.22	1.8	0.0	---	24.2	---	0.0	0.0	---	---	13.4
14-Oct	0	0	0	3	0	0	0	0	0	3	2.80	0.0	---	---	29.5	0.0	0.0	0.0	---	---	22.1
15-Oct	0	0	0	8	0	0	0	0	0	8	7.14	8.3	0.0	---	18.9	---	0.0	---	---	---	13.5
16-Oct	0	0	0	3	0	0	0	0	0	3	4.29	5.3	50.0	---	36.0	---	---	0.0	0.0	---	17.9
17-Oct	0	0	0	1	0	0	0	0	0	1	1.23	4.5	0.0	---	21.4	---	---	---	0.0	---	10.0
18-Oct	0	0	0	1	0	1	0	0	0	2	2.17	4.3	0.0	---	23.1	---	0.0	---	0.0	---	12.2
19-Oct	1	0	0	2	0	0	0	0	0	3	3.13	0.0	0.0	---	15.2	---	0.0	---	---	---	5.4
20-Oct	0	0	0	0	0	0	0	0	0	0	0.00	7.0	0.0	---	13.3	---	---	---	0.0	0.0	9.1
21-Oct	0	0	0	2	0	0	0	0	0	2	2.86	0.0	---	---	17.6	---	0.0	0.0	0.0	---	8.8
22-Oct	0	0	0	1	0	0	0	0	0	1	2.33	17.6	---	---	20.0	---	---	---	---	---	19.0
23-Oct	0	0	0	0	0	0	0	0	0	0	0.00	3.4	---	---	12.9	---	---	0.0	---	---	8.2
24-Oct	2	0	0	0	0	0	0	0	0	2	3.45	3.6	0.0	---	12.5	---	0.0	---	0.0	---	7.1
25-Oct	0	0	0	0	0	0	1	0	0	1	2.38	0.0	---	---	0.0	---	0.0	33.3	---	---	2.4
26-Oct	0	0	0	0	0	0	0	0	0	0	0.00	0.0	---	---	15.4	---	0.0	0.0	0.0	---	5.7
27-Oct	0	0	0	0	0	0	0	0	0	0	0.00	0.0	---	---	16.7	---	---	0.0	---	---	5.6
28-Oct	0	0	0	0	0	0	0	0	0	0	0.00	0.0	33.3	---	0.0	---	---	---	---	---	5.6
29-Oct	0	0	0	0	0	0	0	0	0	0	0.00	11.1	---	---	0.0	---	---	0.0	---	---	7.1
30-Oct	0	0	0	0	0	0	0	0	0	0	0.00	14.3	0.0	---	28.6	---	0.0	---	---	---	17.6
31-Oct	0	0	0	0	0	0	0	0	0	0	0.00	0.0	50.0	---	0.0	---	0.0	---	0.0	---	2.8
1-Nov	1	0	0	0	0	0	0	0	0	1	0.70	1.3	0.0	---	7.7	0.0	0.0	0.0	0.0	---	2.8
	3,275	914	13	1,971	3,410	459	497	88	3	10,630	0.15	3.1	2.3	9.9	4.7	5.3	2.2	4.7	3.0	4.3	4.4

Table 4: Final Disposition of Smolts Collected at Lower Granite Dam, 1998.

TOTAL	Yearling Chinook		Sub-yr Chinook		Steelhead		Coho	Sockeye/Kokanee		
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Unknown	Hatchery	Wild	Total
Collected	1,317,503	287,186	520	81,286	4,527,534	557,991	155,546	48,623	1,025	6,977,214
Total Transported	1,225,569	266,153	507	78,303	4,416,532	539,512	153,575	48,534	1,022	6,729,707
Barged	1,203,805	245,809	489	8,043	4,366,903	521,297	147,145	47,921	990	6,542,402
Trucked	21,764	20,344	18	70,260	49,629	18,215	6,430	613	32	187,305
Bypassed	88,312	20,074	0	1,003	107,561	17,990	1,474	0	0	236,414
Sampled	18,259	7,163	73	24,346	60,789	8,894	4,210	981	26	124,741
Total Mortality	3,275	914	13	1,971	3,410	459	497	88	3	10,630
Facility Mortality	2,934	747	9	671	2,888	397	386	61	0	8,093
Sample Mortality	341	167	4	1,300	522	62	111	27	3	2,537
Research Mortality	347	45	0	9	31	30	0	1	0	463